

THE MARVELS OF ANIMAL INGENUITY



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MARVELS OF ANIMAL INGENUITY



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A WILLING PRISONER

A hornbill constructing a mud wall to protect his partner while she is sitting. When the wall is finished, the entrance to the nest is only just large enough for the hen bird to thrust out her bill and receive the food which is brought by her attentive mate.

THE MARVELS OF ANIMAL INGENUITY

AN INTERESTING ACCOUNT OF THE CURIOUS
HABITS & HOMES OF MANY ANIMALS
BIRDS & INSECTS

BY

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AUTHOR OF
"ROMANCE OF THE MICROSCOPE"
5th c., 6th c.

WITH MANY ILLUSTRATIONS

Philadelphia
J. B. Lippincott Company
London: Seeley, Service & Co. Ltd.
1926

Los Angeles Museum

Exposition Paris

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1926

PREFACE

IN the following pages I have attempted to raise a corner of the veil which shrouds the face of Nature. To disclose her secrets entirely is beyond the power of any human being, so we must be satisfied with a glimpse of a feature here and there which may seem likely to awaken our interest.

There are those who would deny to animals the possession of intelligence; but I trust the pen pictures in this book will prove that they are ingenious, and that many of them are extraordinarily so.

Animal Ingenuity covers a wide field, so wide that I have been compelled to enlist the aid of a number of standard works. Amongst those into which I have delved somewhat deeply are—Dr Wheeler's delightful book on Ants; the works of Mr Chas. Dixon, who so charmingly describes Birds and their habits; Professor Dittmar's monumental work on the Reptiles of the world; Dr Dakin's *Pearls*; Mr Warburton's *Spiders*; Professor J. A. Thompson's *Study of Animal Life*, and, needless to add, that mine of information, the *Cambridge Natural History*. To the authors of these works I make my excuse, that their writings are practically indispensable to one who would pen a book of the nature of *Animal Ingenuity*.

My publishers throughout have shown me such kindness and consideration that I wish to take the opportunity of thanking them here.

C. A. E.

LONDON,
1920.

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PUBLISHERS' NOTE

The contents of this volume are drawn from Mr C. A. Ealand's larger and more expensive volume entitled "Animal Ingenuity of To-Day."

CHAPTER I

SOCIAL BEES AND WASPS

AT the present time there are known to be rather more than five hundred thousand different kinds of animals. Of these, three hundred and fifty thousand are insects. Small wonder, then, that this great class of the Animal Kingdom provides some of the most remarkable examples of animal ingenuity. A well-known writer has described the present time as the Age of Man and Insects, just as earlier times were known as the Age of Reptiles or the Age of Fishes or of backboneless animals. Sad to relate, this host of industrious creatures—insects are rarely lazy—embraces but few kinds that are of immediate benefit to man: the insect goats far outnumber the sheep.

In comparatively recent times it has been discovered that some of the most fell diseases of the human race are carried from man to man, or from animals to man, by insects. But four of the hundreds of thousands of different kinds of insects have been domesticated. A domesticated insect sounds rather an anomaly, but the activities of the honey-bee, the silkworm, the cochineal insect and the lesser known lac insect have actually been subjugated to the will of man.

For the moment we are only concerned with bees, not only honey-bees, but also with certain of their wild relatives. The honey-bee is of very special interest because of its very highly developed social habits, which are only approached by those of the ants and termites. True,

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much of the honey-bee's so-called intelligence has been fostered by man; but, putting aside man's agency, the honey-bee community, as shown by the wild bees, is worthy of close study.

Let us examine a hive that we may learn something of its industrious inmates. Industrious the majority of them certainly are, but there is one kind of individual in every hive who leads a lazy, often useless, life. His very name denotes his uselessness: he is called a drone. The drones are the males. They are always more stoutly built and more hairy than their sisters. Moreover, they are never furnished with any of the special structures for carrying pollen, making or moulding wax, etc., as are the workers. The drones perform one function and one only during their lives: they mate with the queen bee, when necessary. As there is only one queen in each hive and some hundreds of drones, it follows that the majority of drones are simply loafers.

The workers, though really undeveloped females, are practically sexless and, on this account, are often called neuters. They are the smallest, neatest members of the community, but they are beautifully adapted for the work they are called upon to perform, such as building the food and brood cells; gathering, storing and preparing the honey; nursing the young; cleaning, ventilating, warming, repairing and guarding the hive.

Needless to say, the most important member of the community is the queen. She is a fully developed female with a slender, well-proportioned body, about half as large again as the workers. She lays the eggs from which the future stock of the hive will arise; this, in the case of the queen honey-bee, is her sole function. Accordingly she, like the drones, is unprovided with special structures necessary for carrying out the general work of the community. She gathers no food, nor does she construct any part of her nest, thereby differing from the queens of the bumble-bees and social wasps.

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Now, having learned something of the inmates of the hive, let us pay a little attention to some of the events which take place in the bee home. It is better to start at the beginning of the story—that is to say, at the period of the formation of a new community. Everyone has heard of a “swarm” of bees. Most people are aware that a “swarm” consists of one queen and some workers, whose numbers may vary from two to twenty thousand or even more. The reason for swarming may not be so generally known: it simply arises from a desire on the part of the queen to seek a new home. If left to themselves, the swarming bees would find some convenient hollow and settle there, but they are too precious to be allowed to stray in this manner, so the alert bee-keeper transfers them to a new hive.

Once in possession of their home, the workers lose no time in making it habitable. Without delay they secrete wax with which the comb is built up. The formation of wax is a very interesting process. On the under surface of a worker bee there are four pairs of thin, five-sided plates, called wax plates. They are perforated with a number of fine holes through which the wax oozes; it is really formed by certain cells of the skin beneath the plates. The wax-producing workers fortify themselves for their task by eating an inordinate amount of honey—it is said that 1 lb. of wax represents a consumption of 15 lb. of honey. Then they gather together in such a manner as to form a festoon, hanging from the roof of the hive. In this position they remain for hours, or maybe for two or three days, during which time they contrive to increase the temperature of their bodies. Eventually their transparent, shining scales appear on the wax plates. When sufficient wax has been produced it is nipped off by the workers by means of special nippers on their hind legs, chewed up in their mouths so that it will be well mixed with saliva and then taken to the spot where the comb is to be constructed. Here it is compressed and

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moulded by the mouth parts of the worker, which are so modified as to form miniature trowels, till the well-known six-sided cells are formed.

Honey is so frequently sold in combs for the table that it is hardly necessary to add that these cells are always built in a double layer, back to back, a common wall separating the two layers, whilst the open end of each cell is tilted upwards, ever so slightly, to prevent the honey from flowing out. Honey is stored in cells made of new wax ; for the brood cells, which we shall mention presently old wax is used, or even wax mixed with pollen. Bees are exceedingly economical of their wax, and damaged or unwanted cells are pulled to pieces for the sake of their material, which is used in making other cells.

With the completion of the cells the queen, who has already been mated with one of the drones, begins her activities. Selecting certain of the cells, she lays a single fertile egg in the bottom of each one. The other cells are filled by the workers with food in the form of nectar, sipped from flowers and pollen. After three days the eggs deposited by the queen hatch ; a tiny, white, soft-bodied, helpless grub or larva comes from each egg. Their advent is the signal for the nurse workers to bestir themselves, for the grubs are quite unable to feed on their own account. For the first two days their food consists of nourishing "bee jelly," a substance which the nurse workers have already partially digested in their own bodies, pending the time when they regurgitate it to feed their charges from their own mouths. This food is literally pumped into the cells, so that the larvæ are actually bathed in it, and probably a good deal of the food is absorbed through their skins.

Another three days must needs elapse before the nurses have done their duty to their charges. During this time the fare is modified and no longer consists solely of "bee jelly," but also of nectar and pollen, taken from the adjoining cells. After its five days of special diet the

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youngster has grown in size to the extent of nearly filling its cell and in intelligence to the point of being able to feed itself. The nurse accordingly fills up the remainder of the cell with "bee bread," which is merely nectar and pollen, before capping—that is to say, sealing up—its open end with wax. After a day or two, during which the larva finishes its store of food, it changes into a chrysalis or pupa within the cell, and there it remains for nearly a fortnight before emerging as a fully developed worker.

Now a curious thing happens. It is not surprising to learn that the newly born bee remains within the hive for nearly a fortnight before venturing afield on foraging expeditions; it is surprising, however, to learn that the duties assigned to so inexperienced a creature are those of nurse worker. So that aiding in bringing other bees into the world and safely through their infancy is the first duty of the newly arrived worker.

As the queen lays her eggs continuously, the young bees are as continuously making their appearance, and before the lapse of many days a considerable family has arisen. By this time careful study of the comb will reveal certain cells which are larger than their neighbours; in these cells the queen lays unfertilised eggs. The ability of the queen to lay fertilised or unfertilised eggs at will is one of the most extraordinary phenomena in the bee world and has been the cause of considerable argument by naturalists, but that she can do so has been proved beyond a doubt. From these unfertilised eggs arise larvæ which are fed in the manner we have just described, and they develop, eventually, not into workers, but into drones.

Up to this point, excluding always mishaps, everything has gone smoothly for the queen and her enormous family. But sooner or later a time comes when the home is no longer large enough for its inmates, and it is a time fraught with danger for the queen could she but know it. The workers betray their anxiety by becoming vastly excited. They tear down the walls of certain cells and build up a

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veritable giant cell around one of the fertilised eggs. Sometimes several of these cells are constructed. The larva which hatches from the favoured egg is the subject of special treatment by the nurse workers. No common food will suffice for its needs, nectar and pollen are taboo, and throughout its existence it is fed on "bee jelly." After five days the larva can fend for itself, so a store of the jelly is placed beside it and the cell, which by this time has been fashioned roughly to the shape of a filbert, is capped. In a week the fully developed bee eats its way out of the cell, after having intimated that it is about to do so by curious squeaks which are answered by the old queen. After so much care and attention, it is only fitting that something out of the ordinary should come into the bee world, and this is so, for the new arrival is a queen.

It is well to pause here to consider exactly what has happened. Many naturalists own that the surroundings of an animal during its development have an enormous influence on its future, and they draw no small comfort from the case of the bee. The larva from a fertilised egg, laid in a small cell by the queen bee, fed at first on bee jelly, then on nectar and honey, develops into a worker; but the grub from the same egg, if laid in a large cell and fed solely on "bee jelly," turns into a queen. Seeing that the queen and worker bee differ very widely in structure and in habit, the phenomenon is certainly remarkable.

Now there is a law in the bee world which brooks no transgression, to the effect that one hive must harbour but one queen, so the advent of the new queen means trouble, and the trouble is not always of the same kind. Sometimes the rival queens will fight to the death; the only occasion, so it is said, on which the queen bee uses her sting. At other times the workers settle the question among themselves and, gathering in a compact mass round the queen they have decided to destroy, they suffocate or "ball" her. The happiest, and a frequent manner of settling the question is for each of the queens

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to go off in a swarm with some of the workers and form new communities. We mentioned that more than one giant cell may be constructed: this means that there will be several queens in the field, but that all of them should be striving for supremacy at the same time would be too much for any well-conducted hive. The workers surmount the difficulty by walling up the giant cells in such a manner that the emergence of the queens is successive and not simultaneous.

We have told how the community arises and how it is perpetuated, for swarming does not mean the break-up of the old community. We have said little, however, of the tireless activities of the workers. Now the worker bee is a very wonderful creature. In other insect communities, the ants and termites, for example, there are various kinds of workers, modified in structure for the better performance of their special duties. The worker bee, however, is a veritable maid-of-all-work. Each individual is so designed that it may efficiently perform any of the sundry duties that may fall to its lot.

After the initial fortnight spent in nursing, the young worker takes part in foraging expeditions for the purpose of collecting pollen and honey, in the shape of nectar. Each worker bee is clothed with branching hairs which are an invaluable aid in pollen collecting. The pollen is taken from the ripe anthers of flowers, either in the mouth, or the fore-legs, or on the hairs clothing the abdomen of the forager. Having become well laden with the golden dust, the bee manipulates its legs in a manner worthy of a contortionist, and collects its treasure together, before transferring it to the pollen baskets on the thighs of its hind legs. These baskets consist of a hollow, surrounded by stiff bristles which hold the pollen in place. Laden with its booty, the forager returns to the hive and, with the help of its middle legs, takes the pollen from the baskets and deposits it in an empty cell. The inside

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workers attend to the rest by pressing the pollen well into the cell.

Workers also collect nectar. This is sucked up from flowers by the flexible tongue and swallowed into the honey sac, which is really part of the stomach. With its burden, the worker returns to the hive, and either passes the nectar to the mouth of another bee or deposits it in a clean new cell. The honey sac or stomach is a peculiar organ ; it opens into the true stomach by two little slit-like openings. Should the bee become hungry during its peregrinations, it opens these slits and the nectar passes into the true stomach, where it is digested. If it be the aim of the bee to bring its supply to the hive, it keeps the slits shut, so that the only means of exit for the nectar is through its mouth, whence it passes when it is given to another worker or deposited in a cell.

The conversion of nectar into bee honey is one of the most remarkable happenings in the daily work of the hive. Nectar is a very watery liquid, and it is essential that this water be driven off. Now all liquids pass into vapour more readily in moving than in still air, and a high temperature is also helpful. The workers seem to know this, for they contrive a marvellous system of ventilation which at once purifies the air in the hive and helps to drive off the surplus moisture from the nectar. These living ventilators are the hardest worked bees of all. In various parts of the hive, and especially on the floor, they settle themselves, with their heads downwards and their hinder parts pointing upwards, the while they vibrate their wings steadily and persistently, thereby causing a draught. The active workers also, by their very activity on and about the comb, raise the temperature of the hive, and thus contribute to the evaporation of moisture from the nectar.

When the bees are ventilating their abode "a strong current of warm air may easily be felt coming out of the hive, if the hand be quietly brought close to the entrance.

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This process is continued all night to a greater or less extent, and is the cause of the buzzing that may be heard inside any healthy hive long after dark in a summer night." Honey in this state would soon decompose and be useless to the bees as well as to mankind. When one considers all the other marvels of bee life, it is hardly surprising to find that this point has not been neglected. A small quantity of formic acid is added to the honey, to make it keep. It is uncertain whence the bee derives this acid; it has been said that it is supplied by the poison sacs of the sting, which certainly contain formic acid. It is more probably derived, however, from special glands in the head, at the time the nectar is regurgitated.

Besides pollen and nectar, the bees bring water and propolis, a red resinous substance derived from buds, to their home. At times the supply of moisture in the hive reaches a low ebb, despite the rapid evaporation from the watery nectar. As a result the young larvæ are overcome with thirst which must be quenched. Then and then only the foragers fill their honey stomachs with water, sipped as dew from leaves, and carry it back to the parched youngsters in the hive. Propolis is used in the repair of the cells; it is composed of the gummy matter which oozes from certain plants. It is carried by the foragers in their pollen baskets and, on their return to the hive, is used at once and never stored away in any of the cells.

The inside workers, to which, with the exception of the nurses, we have paid scant attention, are no less industrious than the foragers. The greater number, of course, find employment in wax and honey making, cell building and repairing. Others are told off to attend to the ventilation; others, again, keep the hive clean—excreta, old wax, their dead comrades and other refuse, which perforce collects in the hive, are all removed by the workers. Then there are the doorkeepers. The bees

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are too wide awake to allow intruders in their hive if they can help it, so certain workers are given posts as guardians of the entrance. They run about near the door, caressing all and sundry with their feelers, to discover if the strangers' intentions be good or evil. Wasps are frequent intruders, for they are always eager to destroy the honey cells.

By night the inmates of the hive are no more secure, for it is then that the dreaded bee moths, both large and small, steal through the entrance and deposit their eggs about the hive. The larvæ which hatch from these eggs are exceedingly destructive; they devour the wax and at the same time spin a dense silken mantle over the comb. However vigilant the doorkeepers may be, there is one enemy with which they cannot cope, in the shape of a little bee louse, which attaches itself to the hairy coat of the bee and, plunging its mouth into some vulnerable spot, sucks out the life juices of its host.

The well-known bumble-bee dwells in a smaller, less perfect community than its relative the honey-bee; moreover, the workers do not differ very markedly from the queens. With the approach of winter, all the bumble-bees, except a few mated queens, die off. They hide away during the cold weather and spend the time in a semi-torpid state. The advent of warm weather brings each queen bumble-bee from her hiding-place, intent on founding a new community. Unlike her domesticated relative, who takes no part in the building of her home, the bumble-bee queen gathers together an odd assortment of stray herbage and, in some hollow in the ground, constructs a single waxen cell, lined with a paste of pollen and honey. Several eggs are laid in the cell and it is then closed by the mother bee; later on a second and a third cell will be made, each one being fastened to its neighbour by a glue made of pollen and honey. Before long the eggs hatch and the grubs quickly devour the store of food in their cell; then the queen makes a hole

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in the lid of the cell, through which she can feed her grubs from her own mouth.

The first of the new brood of bees are all small females but their diminutive size does not prevent them from helping their mother, with the consequent rapid growth of the community. The construction of further cells is left to the workers; these later cells are not lined with pollen and honey, but the grubs are fed solely by the workers. In the bumble-bee community there are workers of various sizes and their duties appear to depend upon their size. The large workers repair the exterior of the nest and gather honey; the smaller individuals repair the cells and tend the young. At this period the eggs are laid by the queen, several together, in mere hollows scooped out of wax. When the grubs hatch from the eggs they remain in their waxen case, but soon become separated from one another by waxen walls.

The nursing of the larvæ is most interesting. One of the workers makes a small hole in the cell and a nurse bee, having gathered together and prepared a mixture of pollen and honey, injects the brownish liquid through the hole prepared by its fellow. The inmates of the cells devour their sweet provender with evident relish. When they are fully grown they spin silken cocoons, from which they emerge in about three weeks. The vacated cells are promptly put in order by the other workers, their upper parts are bitten off and all the refuse in and around them is removed, so that a number of clean, cup-shaped vessels remain; these are used as receptacles for the storage of the honey and pollen brought to the nest by the foragers. Towards the end of the summer workers no longer arise from the cells; their place is taken by males or drones and fully developed females or queens. These couples leave the nest after their arrival in the world and the bumble-bee community comes to an end.

A curious statement has arisen with regard to these bees, a statement which has oftentimes been confirmed, yet

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is still received with scepticism. It is said that every community, of certain species, is aroused to its daily toil by a trumpeter, who sounds the *réveillé*. He or she must be an early bee, for work with the bumble-bees begins at three o'clock or so, in the early morning.

There is a fly, or rather a bee, in the ointment, or in the wax of the bumble-bee home. A lazy individual who goes so far as to clothe herself in raiment remarkably similar to that of her hosts enters the nest, constructs cells and deposits her eggs therein. And there her labours end, for she leaves the upbringing of her family to the worker bumble-bees and lives an idle life herself, devouring the pollen and honey which the other bees bring to the nest.

Darwin told a neat little story about cats and clover in which bumble-bees are indirectly concerned. We will give the story as it is told by Professor J. A. Thompson, because he carries his point a step further than Darwin. "If the possible seeds in the flowers of the purple clover are to become real seeds," he says, "they must be fertilised by the golden dust or pollen from some adjacent clover plants. But as this pollen is unconsciously carried from flower to flower by the bumble-bees, the proposition must be granted that the more bumble-bees, the better next year's clover crop. The bumble-bees, however, have their enemies in the field-mice or voles; so that the fewer field-mice, the more bumble-bees, and the better next year's clover crop. In the neighbourhood of villages, however, it is well known that the cats make as effective war on the field-mice as the latter do on the bees. So that next year's clover crop is influenced by the number of bumble-bees which varies with the number of field-mice, that is to say, with the abundance of cats; or, to go a step further, with the number of lonely ladies in the village."

We cannot afford a chapter to the social wasps, but they so closely resemble the bumble-bees, in many respects, that it would be superfluous to describe their

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activities in detail. Our common wasps and hornets are all social insects, and their communities, like those of the bumble-bees, come to an end with the approach of autumn. There is one outstanding point of interest about the social wasps: they are the original paper-makers, from which man himself has not been ashamed to copy. Nearly all these insects construct their combs and nests of paper, not coarse imitation stuff, but paper made from real wood-pulp. In fact a South American wasp goes a step further and makes its nest of thick pasteboard, with a covering of paper so fine in texture that it may easily be written upon with pen and ink.

The insects prepare their wood-pulp by scraping the wood fibres from old weather-beaten fences, etc. A careful examination of such places, in the summer-time, will reveal faint scratches, as though made by one's fingernail; these are the marks left by the jaws of the wasps. They chew up the wood with saliva till it is in a fit state for the construction of their nests. As in the case of the bumble-bees, a mated queen, which has survived the winter, founds the colony. These hibernating queens may often be found on lace curtains and similar situations, suspended by their jaws, for their feet are rarely used as supports in this torpid state.

The cells composing the comb are six-sided, like those of the honey-bee; but they are made of paper instead of wax, for no wasp possesses the wax plates of the honey-bee; the cells also are in a single instead of a double layer. In most cases the cells are vertical, a position which one might consider dangerous for the young grub. Every provision, however, is made against its falling out. When young it is glued to the cell; as it grows older it becomes so plump that it is wedged tightly between the encircling cell walls.

The queen herself constructs the first cells of the nest, and her work may always be distinguished by the finer texture of the material used in its construction. She

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covers these cells with an umbrella-shaped shelter to protect them from moisture and keep them warm. Later this shelter is made into a complete envelope for the cells, but for a small opening on the lower surface—a door for the wasps to enter and leave their home. In each of her cells the queen deposits a single egg and in about a week the larvæ hatch. The queen feeds them on insect food which they are able to masticate in their relatively strong jaws. They grow so rapidly that their mother perforce must make constant additions to the length of their cells, lest they outgrow their temporary homes. Within the cell the grub spins a silken cocoon, from which it emerges in about a month from the time of egg-laying as a perfect wasp. Her first impulse on coming into the world is to clean herself, and her toilet is performed with the greatest care. She carries her brush and comb on her front legs, so they are always at hand when she requires them. Her toilet completed, she visits some of the larvæ which are almost ready to spin their cocoons and caresses their heads.

Evidently pleased with such unwonted attention, the larvæ give up a minute drop of liquid which the young wasp readily drinks. For the first two days she helps the queen to feed the larvæ, after that she leaves the nest and becomes a forager of food or wood-pulp. With the arrival of the first dozen or so workers the queen relinquishes all her work, with the exception of egg-laying. The workers enlarge the nest as the exigencies of the family may dictate; often it is necessary to make the burrow, in which the nest is situated, more commodious. Then the workers may be seen issuing in a living stream, each one bearing a little pellet of earth in its mouth, a tiny contribution towards the engineering feats of the community.

Though man has copied the paper-making of the social wasps, he has not yet gone so far as to emulate their architecture, and it would be difficult to do so, for the wasps build their houses from above downwards. We could hardly build our attics before our basements.

CHAPTER II

SOLITARY BEES AND WASPS

OF the so-called solitary bees, none are more interesting or display more ingenuity in the construction of their nests than the leaf-cutting bees of this country. To lie on a bed of roses is supposed to signify a life of ease and luxury; maybe this is the lot of the young leaf-cutter bees, for in their larval stage, at any rate, if they are not, strictly speaking, provided with beds of roses, their abodes are lined with rose leaves. Usually the leaf-cutter bee selects some old and weather-beaten willow for its nest; in one of the branches of the tree it makes a tunnel, a feat which is easily accomplished, for the pith has generally decayed away. Sometimes the burrow is in the ground, then some disused worm-hole comes in handy.

Wherever the site, when it is once settled the mother bee betakes herself to some plant, a rose-bush or privet or to some gaudy-petalled flower, such as a geranium, and busies herself with a careful examination of its leaves or flowers. The rose-bush seems to be the favourite. When she has once made up her mind which is the most suitable leaf for her operations, she loses no time in cutting it up. There is no neater cutter of material in Savile Row than the leaf-cutter bee. Perfectly circular or oval pieces are cut, according to the use to which they are to be put. So accurate are the circles that one cannot help wondering how the insect accomplishes the feat. A peep at one of these bees at work will soon provide an explanation.

During the performance of her feat the bee converts herself into a living compass. She straddles the margin of the leaf with her hind legs, plants them firmly against either surface, thus using her legs as one arm of the

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compass; with her mouth as the second arm she bites her way through the tissues of the leaf. Towards the end of the cut her wings begin to vibrate rapidly, and not without reason, for with the severance of the piece of leaf she will be left without any solid support.

Directly the leaf is cut she folds her piece in the middle, takes firm hold with three legs on each side and flies off with it to her tunnel. She bends the piece of leaf to fit the curve of the walls of her tunnel and pushes it through the opening. This performance she repeats time and again, using circular pieces for the ends of her cells and oblong ones for the sides. Eventually she contrives one of the prettiest pieces of insect handiwork imaginable. Each little cell resembles a miniature thimble composed solely of leaves or petals, glued together with wax. Each piece of leaf includes a portion of the serrated margin, an arrangement which appears to aid in the better adhesion of the pieces. In each cell the mother bee deposits a single egg and a little bee bread. Then she puts a circular piece of leaf on the top and proceeds with the construction of another cell, and so on, till she has built up a string of cells, maybe two inches or more in length, and so strong that, with the drying of the leaves, they will bear comparatively rough treatment. Often the complete nests contain as many as thirty cells, with an average of about the same number of pieces of leaf in each cell. Nearly a thousand rose-leaf snippings, all cut with mathematical accuracy, represents no mean feat on the part of the bee, and the expenditure of about three weeks' labour.

This industrious little bee is not without her enemies and, curiously enough, the worst of them is one of her own kind. The parasite bee is a cunning creature. Experience has taught it that, from the nature of her work, the leaf-cutter bee must needs be absent from home very frequently. This is the eventuality for which the parasite is waiting. When the leaf cell is partly completed, and the owner has

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begun to store it with bee bread, the intruder secretly and rapidly enters and deposits a single egg in the food mass. The leaf-cutter, unaware that there is anything wrong, continues her work, fully stocks her cell with food, lays an egg therein and seals it with a circular piece of leaf. Then she proceeds with the construction of another cell in blissful ignorance that her labour is in vain. The larva of the parasite bee is the first to hatch, but it is followed a little later by the rightful owner of the cell. Both larvæ feed on the bee bread, the parasite from below, the leaf-cutter from above.

The parasite, having the bigger appetite, grows the faster and soon reaches his less fortunate cell companion. When they meet a battle royal takes place, in which the larger and stronger parasite always comes off victorious. Not content with this treatment, and having finished the store of bee bread, it makes a meal of its victim. A little later, instead of a leaf-cutter bee, a parasite bee emerges from the cell. As the leaf-cutter, though ingenious, can hardly be called a friend of the rose-grower, perhaps the tragedy enacted in the leafy cell is all for the best, in this best of all worlds.

The carpenter-bees, or rather their architectural efforts, are not altogether dissimilar to those of the bees we have just mentioned. For the most part they are tropical insects and remarkable for their enormous size. In appearance they somewhat resemble very large bumble-bees, though their bodies are flatter and less hairy. Sometimes the males and females are so unlike one another that they have been described by entomologists as belonging to different species. Whatever the species and whatever its habitat, the carpenter-bee always works in the same methodical way—that is to say, when it does work, for not all bees are industrious and this bee, given the opportunity, is one of the lazy ones, using an old nest in preference to making a new one.

Let us watch this insect carpenter at work and note that

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she leaves nothing to chance. Her first care is to select a site for her home, and this is either a dead tree, a wooden post or some similar structure. Having chosen a suitable spot, she proceeds to bore a perfectly symmetrical hole, just large enough to permit her to enter, across the grain of the wood. She bores in this manner, using her jaws for the purpose, till the cavity is just the length of her body. Then she turns at right angles and tunnels directly downwards, with the grain, for from eighteen inches to two feet. Her rate of progress depends largely on the hardness of the wood, but in moderately hard timber she tunnels almost half-an-inch a day.

All the sawdust which is made during her work is used by the bee at a later stage and for the time being is carefully stored away in safe keeping, usually in some hollow in the tree on which she is working. Having completed her task as a carpenter, the bee flies around and seeks honey and pollen with which she stores the bottom of her tunnel. On this "bee bread" she deposits a single egg and then proceeds to build a roof, composed of the sawdust she has saved, mingled with her saliva. The roof or partitions which form chambers in the tunnel vary in structure with the different kinds of carpenter-bee. In general, they are about the thickness of a penny and composed of about four layers of macerated sawdust. Each partition forms a roof to the cell below and a floor to the one above; the roofs are rough and flat, whilst the floors are smooth and concave. The bee repeats her work time and again till, in the end, the completed nest is composed of a tunnel divided into several chambers, often as many as twelve, one above the other. In each chamber there is a store of "bee bread" and a single egg. When her labours are almost completed, the last act of the mother bee is to seal the mouth of the tunnel with the same material she has used in making its partitions.

There is a family of very small yet very active little bees, some of which are native to this country, which are known

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as small carpenter-bees. They have been given the name because their nests somewhat resemble those of the true carpenter-bees. These diminutive insects are not hairy, as are most of the other bees, yet they are remarkable for the brilliancy of their colouring, the prevailing shades being blue, blue-black, black or green, with a metallic sheen. Being tiny creatures, they do not possess the architectural capabilities of the bees from which they take their name, so they select plants with a soft pith for their operations. The British species makes its home in the bramble; hunting about till it finds a broken branch, it has no difficulty in scooping the pith from within. The whole of the tunnel thus formed is lined with a delicate silky membrane. It is partitioned into chambers, much in the same way as is the tunnel of the carpenter-bee, but, instead of using the material taken from its burrow for the purpose, the bee collects little pellets of mud and with these constructs her partitions, storing each cell with honey, pollen and a single egg after the manner of all solitary bees.

The wool-carder bee constructs a nest which is worthy of notice; in appearance it is a ball of white wool enclosing the wax cells. It is said of this bee that it never makes a hole of its own in which to place its nest, but that it prefers door locks, snail shells, etc. The "wool" of which this bee constructs its nest is obtained from the hairs of various plants. Gilbert White, in his *Natural History of Selborne*, wrote of this insect: "There is a sort of wild bee frequenting the garden-campion for the sake of its tomentum, which probably it turns to some purpose in the business of nidification. It is very pleasant to see with what address it strips off the pubes, running from the top to the bottom of the branch, and shaving it bare with the dexterity of a hoop-shaver. When it has got a bundle almost as large as itself it flies away, holding it secure between its chin and its fore-legs."

The ingenuity displayed by the solitary bee is diverted

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into the most varied channels. We have mentioned the leaf-cutters and carpenters, then there are potters and masons; cuckoo-bees, so called because they resemble cuckoos in habit, as nearly as an insect can resemble a bird; blunt-tongued burrowing bees and sharp-tongued bees of similar habit. Of the latter there are an enormous number of species in this country alone. They, or rather the females, dig moderately deep holes in the soil—clay is preferred—and at the end of the burrow an oval chamber is constructed. The walls of these chambers are always quite hard, for they are well “puddled” by the females, and not without reason. They are used as storehouses for the honey and pollen destined to nourish the larvæ, so that, unless the walls were well hardened, the honey would soak into the soil and be lost to the bee. Nature seems to have ordained that the males of the sharp-tongued burrowing bees should be lazy, for she has provided them with fore-legs which are useless for digging and hind legs which are unable to carry pollen.

The solitary wasps differ from the bees of similar habit in one very remarkable particular: whereas the food of the bee larva in every case consists of “bee bread,” that of the wasp larvæ always consists of insects, and each species of solitary wasps stores its larder with a special kind of insect. Some of these wasps are partial to spiders, which, by the way, are not insects at all; others prefer beetles, others again cockroaches or locusts or cicadas, and so on, each species exhibiting a partiality for a particular species of insect. Of the solitary wasps none are more interesting than the sand-wasps. Small wonder that Fabre, who was described as the insects’ Homer, made them the object of special study. Though others have described their habits more accurately, the French naturalist always contrived to weave a beautiful romance around his beloved insects and their doings.

The sand-wasps excavate tunnels in the earth, using their mouths for the work. Their jaws are remarkably

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strong, and with them they bite at the earth till they have removed a pellet. Then they come to the surface with their burden in their mouths and deposit it a short distance away from the entrance to their burrow. All the time they are at work they keep up a loud buzzing, apparently with the object of scaring away strangers. After the completion of her burrowing operations the female covers the door of her nest with a small pebble, and over this, in turn, she scrapes dry earth, tamping it down, marvellous to relate, with a small stone held in her powerful jaws. Over all she often places a few pieces of dried grass. The solicitude of the mother wasp for the effectual concealment of her burrow is one of the most remarkable traits of these wonderful insects. Sometimes the wasp will return again and again to the site of her home, to assure herself that all is well. On these visits she frequently places other objects over the burrow to make assurance doubly sure.

Having made certain that she has done all that is possible to hide her nest, the wasp hunts about for insect prey. Some sand-wasps prefer caterpillars and others spiders. Having found a suitable insect for her purpose, she stings it in such a manner that, although it is for ever incapable of movement, it does not actually die, and there is reason in her action. Bearing her burden with unerring accuracy to her burrow, she removes the earth and stones from its mouth and enters, dragging her paralysed prey after her. The end of the burrow is formed into a chamber. Here she leaves her living burden, deposits an egg upon it and flies away in search of further provision for her larder, after carefully closing and concealing the entrance to her home. More provender is collected and stored in the same way and an egg deposited upon each individual, then the life work of the mother wasp is completed. Her last act is to conceal the entrance to her burrow, and this she does with scrupulous care, for nevermore will she be able to tend it. Satisfied with her efforts,

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she flies away as far as her failing strength will carry her and dies. The young sand-wasps, however, will perpetuate her work, for her eggs will furnish lusty grubs well provided with living food, seeing that their mother was careful to paralyse and not to kill her prey, thereby ensuring that it would be in fresh condition for her offspring.

Two American entomologists noticed a very distinct personality among the female sand-wasps they watched at work. "This personality was not of individual appearance but of such mental attributes as careful painstaking or carelessness, and industry or laziness. One seemed to hurry tremendously and spent no time on non-essentials. Another was an artist, working for a long time on the closing of her burrow, arranging the surface with scrupulous care and sweeping away every possible particle of dust to a distance. Still another went to the extreme in carelessness, carrying the caterpillar in a very careless way and making a nest which was a very poor affair. Still a fourth was the most fastidious and perfect little worker of the whole season, so nice was she in her adaptation of means to ends, so busy and contented in her labour of love, and so pretty in her pride of her completed work. In fact, they seem to have almost as much individuality as human beings, and the result of these observations has a strong bearing on the discussion of instinct." Fabre, the French entomologist, who studied the same insects, considered that they were inspired by automatically perfect instincts which can never have varied to any appreciable extent from the beginning of time. Deviation from the regular rule, he thought, would mean extinction. The American authorities, however, found that variability was "the one unmistakable and ever-present fact, and this variability existed in every particular: in the shape of the nest and in the manner of digging it, whether it is left closed or open, in the manner of stinging the prey and of crushing it, in the manner of carrying the victim, in the way of closing the nest and in the condition

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produced in the victim by the stinging, some dying and others living for a long time though nearly motionless."

Every imaginable variation of the nesting and food-storing habits of the sand-wasps may be found amongst their near relatives. One solitary wasp lays in a store of cockroaches; its nest is always built in walls between the crevices of the stones, and the entrance thereto is usually large enough to admit an average-sized cockroach. Now the cockroach, for reasons which it is outside our province to discuss, is very variable in size—in short, it grows—and unlike the wasp which preys upon it, or the house-fly or the dragon-fly, is not of the same dimensions when it makes its entrance into the world as when it makes its exit. This is awkward for the wasp, for a day assuredly arrives when its prey is too large to be dragged into the nest. Such a happening, however, does not daunt the little huntress. Her first act is to snip off the horny wing-cases of her victim, thereby allowing its body to be compressed. Then probably a leg will become jammed in the doorway and cause an obstruction; again the wasp is equal to the occasion and amputates the offending limb, and so on, till finally the sadly dismembered cockroach is safely within the burrow.

Another of these wasps does not seem to have fully learned the art of completely paralysing the creatures destined for the food of its grubs. Moreover, it is obviously conscious of its shortcomings, therefore the spiders on which it preys suffer amputation of their legs, so that, should they recover consciousness, they are unable to escape from the nest. The case of yet another of these wasps is even more hopeless, at least it would be hopeless but for the ingenuity of the mother wasp. As one writer aptly puts it, she has not inherited from her ancestors the receipt for the paralysing sting. It is impossible, therefore, for this wasp to lay up a store of living food. She builds her nest somewhat after the fashion of the sand-wasp and deposits her eggs therein. At the time the

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larvæ emerge the mother wasp goes on a foraging expedition and returns with a small fly, with which she feeds her progeny. Each time she leaves the nest she carefully covers the entrance; every time she returns with prey she must perforce remove the covering. As the larvæ grow so do the flies supplied by the mother wasp increase in size; starting with the most minute flies, she so orders her household that the final larvæ meals shall consist of plump gadflies. She feeds her young exactly after the manner of a bird, with the added labour of filling up the entrance to her nest over and over again.

A straightforward recital of the ingenious nesting habits of the solitary wasps conveys no idea of the dangers they encounter in their hunt for prey. Crickets and locusts, which some of them attack, are provided with very strong hind legs, and active withal, so that a false move on the part of the wasp would afford the victim a chance to disembowel its enemy—a chance that would not be allowed to pass. Certain solitary wasps prey upon spiders much larger than themselves, and spiders possess cruel poison fangs which they do not hesitate to use. Is it surprising, then, to learn that the wasps engage in sham fights with one another, to keep in training for their encounters with the spiders? Mr Latter thus describes one of these sparring matches: “Frequently two females—note this is no love dance, for both are females—may be seen to settle down face to face on a patch of sand, to move round and round as though searching for an opportunity, to lean over first on one and then on the other side, and from time to time to lash round with their wonderfully flexible abdomens as though delivering a stab from the venomous sting.

“In their actual encounters with the spiders it behoves them ever to face the enemy, for the poison fangs of the spider are situated at the head end, and it is thus from that quarter that danger threatens. The wasp, on the contrary, carries her weapon at the tip of her tail, and

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needs to be expert in at once keeping her eye on the foe and at the same time delivering an attack from her rear armament. Of course the poor spider is heavily handicapped by the absence of wings, which enable the wasp to move and make circles round her less agile opponent."

The graceful little mud-wasps are often described in natural history books, because of their curiously formed little earthen nests, and the still more extraordinary places in which they build them, such as door-locks, window catches, cotton reels, and the like. An ingenious nesting habit which is rarely mentioned is worth a moment's attention. In each cell the little wasp deposits a single egg and a store of paralysed caterpillars, which, by the way, are usually pushed into their hiding-place by means of the wasp's head. The egg is always suspended by a silken thread to the roof of the cell in such a manner that it hangs just clear of the nearest caterpillar. The wasp grub, when it comes into the world, is very fragile, and might easily be mortally wounded by any movement on the part of its living fare. Therefore, tethered as it were to the silken thread, it makes its first meal out of harm's way, off the nearest caterpillar. But more wonders are yet to come. It is necessary for the wasp larva to reach more food, and it is yet too feeble to venture alone in its larder. The difficulty is overcome in this manner. The egg, from which the larva has emerged, breaks up into a ribbon, thereby lengthening the tether and enabling the hungry little being to reach more of its food supply. With increasing age the young wasp larva gains strength, so that the last of its provisions, in the shape of the caterpillars, are devoured without the aid of the protecting silken thread.

CHAPTER III

ANTS

NO insect, with the possible exception of the bee, has been more highly and more frequently eulogised than the ant. From Biblical times to the present day its industry has been considered worthy of imitation. There is another, more subtle, reason why the ant appeals to man. Its habit of living in permanent communities bears an undeniable resemblance to our own condition. "In order to live in permanent commonwealths an organism must be not only remarkably adaptive to changes in its external environment, but must also have an intense feeling of co-operation, forbearance and affection towards the other members of its community."

Ants occupy a unique position in the insect world because of the number of their individuals and kinds; their wide distribution over the earth; their longevity, their perfect adaptation and special modes of life and their relationships with plants and other animals, including man. Wherever one goes, ants may be found—from the Polar regions to the Tropics, from the dampest forests to the driest deserts, on the summits of the highest mountains or on the seashore. Their colonies often outlive a generation of men. They are not handicapped in their mode of life like other social insects; their diet is not restricted, as in the case of the termites and bees; nor as a rule, do they build their nests of expensive material so that they can easily remove themselves and their broods to another place, when their nest is threatened with destruction or when weather conditions are unfavourable. Espinas says, that ants owe their success to their terrestrial habits. "When it is necessary for an aerial animal, like

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the bee, to build its nest it must either secrete the substance of its nest or seek it at a distance, as does the bee when she collects propolis, or the wasp when she gathers material for her paper. The terrestrial animal, like the ant, has its building materials close at hand, and its architecture may be as varied as these materials." Also ants have few enemies, a fact which caused the naturalist Forel to remark that "the ant's most dangerous enemies are other ants, just as man's most dangerous enemies are other men."

It is curious to note how ant societies resemble and differ from those of man. Human societies may be divided into six classes or stages—the hunting, pastoral, agricultural, commercial, industrial and intellectual; and ants have stages corresponding to the first three. Some ants live solely by the products of the chase: they are known as driver and legionary ants; some keep domestic animals, in the shape of plant lice, scale insects and caterpillars, these belong to the pastoral class; the agricultural class is represented by the harvesting-ants, which collect, store and, it is said, plant seeds. Against these resemblances may be set the fact that ant societies are almost solely composed of females, for the males take little part in the social life of the colony; each female is predestined to a certain task, and an ant community may be likened to a big family. A very big family in some cases, for Forel has estimated that a community may consist of five hundred thousand individuals. Such a community resembles a perfect republic where each works for the good of the whole community, each having her appointed work, labouring constantly for the good of all and each ready to sacrifice herself for the good of all. A veritable insect Utopia.

Before we turn our attention to some of the more extraordinary ant colonies let us examine the typical life history of these insects. An ant's nest may be built above or below ground; in hollows in trees; in plant galls;

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in decaying wood—in fact, no situation may be said to be wholly unsuitable for a nest if the right kind of ant is at hand to make use of it. With few exceptions, the general life of one community is very similar to that of any other. At the end of her nuptial flight, the mated queen returns to her hiding-place, below ground if she belongs to an earth-frequenting kind, and her first care is to rid herself of her wings, which henceforth will be useless to her. The offending encumbrances are either pulled off with her legs and jaws, or rubbed against stones, grass blades and the like, till they break away. Having performed this surgical operation, which, in reality, is not very difficult, for the wings easily break away after their one flight, the queen, whose body is well stored with fat, proceeds to found her colony by herself. She makes a little burrow in the soil and enlarges the blind end into a chamber and, having done so, she closes the entrance. This engineering feat costs the ant much tribulation; she wears away her jaws, with which she excavates the soil, rubs the hairs from her body and, at length, with scratched and bruised armour, she settles down unaccompanied and lonely, in her little chamber for days, weeks or even months, till her eggs are ready to be laid.

At length the eggs are deposited in a little packet, and from them very small grubs emerge. These new-comers are nourished by the saliva of the queen, which, in turn, is derived from the fat stored in her body, for she takes no food during the whole of the time she is founding her colony. They grow slowly and little, but, mishaps aside, they eventually develop into undersized workers, whose first care is to break a way into the outer air and proceed with the enlargement of the nest. But let us first of all follow the fortunes of the queen. The newly hatched workers bring her food, but she takes little interest in her progeny; at their birth she becomes excessively timid and shuns the light, her sole care is to produce more and more eggs. She laps the liquid food which her attendants

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bring her and regains some of her original plumpness, but she remains all the time, perhaps for fifteen years, a lonely self-sacrificing, egg-laying machine.

In an incredibly short time the community is in full swing. The ill-formed original workers are replaced by more lusty individuals, as the eggs, so freely provided by the queen, mature. These eggs are elongate and yellowish; they are always laid in clusters and not in special cells, as with the social bees and wasps. The greatest care is bestowed upon them by the workers. Almost hourly they lick their charges, covering them with saliva, which causes them to stick together in batches and also acts as an antiseptic, preventing the growth of harmful moulds. The drying of the eggs and their consequent falling away into separate units would be very inconvenient for the workers. Single eggs would entail much labour in transport, batches of eggs are more easily carried, and an accident to the nest might render necessary their rapid removal to a place of safety.

Also, as the temperature and moisture of the nest varies from hour to hour, so do the workers carry the eggs from chamber to chamber in the nest in an endeavour to keep the conditions equable. As they are held together by saliva it is possible to move several at a time. The grubs which hatch from the later eggs of the queen or queens—each nest may contain as many as thirty of these royal insects—are just as helpless as were their elder brothers and sisters. They are translucent, soft-bodied, blind, legless, helpless little creatures, in shape like a miniature “crook-necked” gourd. Sometimes they are hairless but more often hairy, to their advantage. A hairy coat raises their bodies a little way from the ground and so preserves them from damp, just as one raises a wooden hut from the ground to allow a current of air to pass beneath. Such a coat acts as a protection against their elder sisters who may feel hungry, for ants are cannibals on occasion; it causes them to stick together in groups, an advantage in

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transport, as we have seen in the case of the eggs. Some grubs have hooked hairs, and these are very useful, for by their means the workers simply hang the youngsters to the wall of the nest out of harm's way, much as an Indian squaw hangs her baby to her tent.

Now the grubs are so helpless that they give their nurses no end of trouble. In the first place, they are quite unable to feed themselves, so their nurses supply them with nourishment from their own mouths, which may consist of partly digested food, masticated insects caught by the workers, portions of seeds or other vegetable matter. In some communities, the soldier ants, which we shall speak of later, are appointed carvers and cut up tough-skinned insects for the grubs ; in other communities the soldiers act as official nut-crackers to the colony. For a month or more the nursing continues, and during all this time the nurses are kept very busy. In order that the grubs may develop into healthy, well-grown ants it is necessary that during their various stages of growth they should be surrounded with an atmosphere of constant temperature and humidity ; they require different conditions at different stages of development. To bring this about the nurses remove their charges from place to place within the nest. They are arranged in piles according to their ages : this alone is a heavy task for the nurses. In addition, the grubs are constantly cleaned by licking : particles of soil must not be allowed to stick to their delicate bodies. The nurses' saliva also acts as a waterproof and an antiseptic covering for the grubs. A further duty consists in protecting the youngsters from light and enemies. Usually they are stored in the darkest recesses of the nest ; however, the nurses of one Texan species are in the habit of bringing their charges to the surface after nightfall, and slowly promenading up and down with them, after the manner of human beings.

At length the grubs reach the stage at which it is necessary to change into chrysalids. Here again the

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nurses lend their aid. The grub cannot spin its cocoon without some points of attachment for its silk, so what do the nurses do? They embed the grubs in the earth till they have spun their silken cocoons; then, the operation complete, they dig them up and store them in their different piles, according to age, as they did with the grub. These cocoons are sold under the misleading name of ants' eggs, and used, amongst other things, for feeding gold-fish. In the cocoon wonderful changes take place as the ant grub transforms into the adult insect. When these changes are almost complete the nurses once more come to the rescue. Splitting up the silken envelope, they remove the helpless half-formed ant from within.

In this stage the creature is known as a callow, and it is in very fact unfledged. The callow is helpless, its legs, feelers and wings, if it be a winged form, are closely folded to its body; all these organs are carefully cleaned, licked dry and unfolded by the diligent nurses. In short, they literally set the callow on its feet. When the time arrives for the formation of a new colony, and the consequent mating of the queens, a curious thing happens.

It is well known that mating with near relatives is bad for any animals. How is this prevented by the ants? By a remarkable dispensation, the nuptial flights of the members of all the adjoining nests take place at precisely the same moment, so that there is every chance of a queen mating with a male from another nest. Just before the flight the workers may often be observed holding back the impatient males and queens till the proper time arrives. In these nuptial flights there are always hundreds of queens, and in this respect they differ widely from a swarm of bees, where one queen only is concerned. This, in short, is the life story of a typical ant community.

The structure of the nests, the number of castes—that is to say, individuals modified in some special manner for the accomplishment of definite duties—the habits of the workers differ widely in the various species. The nests

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are so varied that we can only mention a few of the more interesting; the castes so numerous that only those with which we are immediately concerned will be described; the ways of the workers—well, volumes have been filled with their doings. In certain respects all ants are alike. They are all exceedingly cleanly. It is hardly surprising that large quantities of waste matter, excrement, cast skins and the like, should be found in the nests, or would be were the ants not so tidy. Every scrap of rubbish is carefully removed by the workers, either to some place outside the nest or to a deserted gallery within it. Veritable little kitchen middens are these rubbish-heaps. Any evil-smelling substance which finds its way into the nest and cannot be removed is dealt with equally promptly. The ants simply throw little pellets of earth upon the offending object till it is buried.

All ants, with the exception of some flesh-eating species, have a common failing—they are all partial to sweet things. In this connection there is nothing more remarkable in the ant world than the “honey pots” of a small American ant. The nest of this ant is never very large, and is always situated in the vicinity of shin oak thickets, for a reason which will be apparent in a moment. Externally, the home of the honey-ant is a low, gravel-covered mound, about six inches in diameter by three inches in height. Internally, it contains certain special chambers with dome-shaped roofs, to the rough surfaces of which certain peculiarly contrived individuals cling.

The ordinary workers display little activity by day, but at night they issue from their nests in thousands and ascend the oak-trees. Now the shin oak is especially liable to the attacks of gall insects, and there is a certain gall which gives off a sugary substance called honey-dew. It is for the honey on these galls, together with the sweet exudations of green-fly and scale insects living on the oaks, that the nightly forays of the ants are made. The worker ants lick up all the honey-dew they can find and



A RIDE ON BEETLE-BACK, AND A LIVING SWEET-SHOP.

Enjoyment seems to be the only motive the fly has for riding on the back of the African beetle shown in the upper part of this illustration. Beneath is shown the well named honey-pot ant with its distended body full of honey, which it gives away to any hungry working ant.

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return to the nest fully laden. Once in their home, they lose no time in seeking out the individuals waiting for them in the vaulted chambers. The mouths of forager and prospective honey-pot are closely applied, the honey-dew is regurgitated by the worker and absorbed by its fellow till it becomes so distended as to resemble a six-legged currant. It is changed into a positive living storehouse, filled with grape sugar. So utterly incapable of movement does it become, by reason of its sugary burden, that, should it fall by accident from its vaulted roof, it will lie, with its legs in the air, a helpless mass of ant anatomy.

Why, it may be asked, should the worker ants display such solicitude for their seemingly lazy relatives? Be assured there is a reason for their behaviour. Bad times may fall upon the community, either through drought or the natural sequence of the seasons. Then, at anyrate, the honey-ants become objects of prime importance. Hungry workers will stroke them gently with their feelers and, pleased with such unwonted attention, the "honey pots" disgorge their store of grape sugar, drop by drop, to the evident delight of the workers. As Dr Wheeler has remarked: "Those who are wont to extol the fervid industry and extraordinary feats of muscular endurance in ants should not overlook the beatific patience and self-sacrifice displayed by the replete ant as it hangs from the rafters of its nest, month in, month out—perhaps for years—a reservoir of temperamental as well as liquid sweetness."

The cultivation of mushrooms might be thought to be beyond the powers of even the intelligent ant; well, ants do not cultivate the mushrooms we are accustomed to eat, but they come very near to it. They grow fungi of various kinds in their underground nests. These fungus-growing ants all dwell in tropical America, and very destructive they are, for they have a pernicious habit of removing leaves from trees and carrying them to their

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nests. Why they do so remained a mystery for a long time. Some naturalists concluded that they used the leaves as food, others that they lined their nests with them; the real use, however, of this vegetable matter is to act as a manure on which their much-loved fungus will grow.

The nests of these ants consist of numerous rounded, underground chambers, about as large as a man's head, connected together by tunnels. In these chambers there is stored a speckled, brown, spongy mass of vegetable matter, the prepared leaves, interwoven with a minute white fungus. Other vegetable matter, including the white rind of oranges, is used for the same purpose. An astonishing thing about these ants is the care they take over the ventilation of their fungus beds. Numerous tunnels connect the chambers with the air. These are constantly opened, and as often closed, to keep up a regular temperature. Certain of the workers are told off to weed these fungus gardens, and the task is no light one, because the vegetable manure is a favourable medium for the growth of many kinds of fungi, but the ants only permit one kind to flourish.

When a move is made to a fresh nest, portions of the fungus are taken to the new home by the workers so that the food supply may remain unimpaired, but stranger still is the proceeding when the queen sets forth to start a new colony. When she leaves her nest for the marriage flight she takes with her the remains of her last meal, consisting of her favoured fungus. After mating, she digs a hole in the ground, closes its opening to the outside world and sets to work to found a colony. She spits out the pellet of fungus threads and cultivates it, while she is at the same time laying eggs and rearing the larvæ. Wonder upon wonder confronts us in the study of these marvellous insects. How does the solitary, fully occupied queen gather leaves on which to grow her little store of fungus? She uses no leaves, but simply crushes up a few

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of her first formed eggs in her mouth, and on this medium the fungus flourishes exceedingly.

As the young ants develop, the queen must needs tend her fungus garden as well as her offspring, for the fungus is a necessary food for the young ants. From time to time the queen tears off a little of the fungus growth in her mouth and holds it to the tip of her body. At the same time she gives forth a small drop of brownish liquid which is rapidly absorbed by the fungus. Then she inserts the little tuft amongst the main fungus growth and puts it into place with her fore-feet. This operation is repeated once or twice an hour, and the fungus thrives on its manuring. Sometimes a queen will find herself without a fungus garden, then another queen will present her with sufficient of the growth to start horticultural operations, to her evident delight.

The first grubs to hatch do not feed on the fungus, as might be expected, but are fed by their mother on her own eggs. As soon as they are grown into fully fledged workers they enlarge the nest by making other chambers; they bring pieces of leaves, cut them into minute wads and insert them in the fungus garden. The manuring of the garden by the queen ceases, and she degenerates into a sluggish egg-laying machine.

From the fungus-growing to the harvesting-ants is not a very far cry. Harvesters are found in practically all the warmer parts of the earth, and wherever they live their habits are very similar. They usually scour the country in droves, gathering seeds of all sorts as they go and returning with them to their underground nests, where they are stored in special chambers or granaries, to be used as food for the young and for themselves. More extraordinary than their proven habits are the stories that have been woven round their doings. They are said to bite off the young growing points from the seeds in order to prevent them from germinating. So far from this being the truth, the stored seeds often germinate within the

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granaries and are then promptly thrown out by the tenants. True, the ants take the skins from all the seeds before storing and carry the husks outside their nests, but nipping off the growing points—never!

Another fable of the harvesters is that they cultivate certain plants on the mounds over their nests, for the sake of their seeds. Careful observation has shown that these so-called cultivated plants are simply throw-outs from their nests. As one writer remarked: "To say that the ant, like a provident farmer, sows this cereal and guards and weeds it for the sake of garnering its grain, is as absurd as to say that the family cook is planting and maintaining an orchard when some of the peach stones, which she has carelessly thrown into the backyard with the other kitchen refuse, chance to grow into peach-trees."

Of the other ants with horticultural proclivities, the most remarkable are those Brazilian species which build "ant gardens." These gardens are composed of particles of earth, carried into trees by the ants and built up into spherical masses bearing a close resemblance to bath sponges. According to the naturalist who discovered them, the seeds of certain plants are carried up the trees by the insects and planted in the masses of earth, in order that their roots may bind the soil particles more firmly together.

The relations of ants to plants are many and varied, and form a special study in themselves. Certain ants dwell in the thorns of acacia-trees and sally forth to protect their living home from the ravages of leaf-cutting ants when these destructive insects threaten an attack. Another species of ant dwells in a large gall, with a single opening, which is plugged, day in day out, with a living stopper, and in this manner. Some of the workers of this species are known as soldiers and, as always happens among soldier ants, are possessed of very large heads and powerful jaws. The galls in which the ants take up their abode resemble large, hollow oranges. Entrance to and exit from the

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cavity of the gall is by means of the single hole which is exactly the size of the soldier's head, and there he sits, an animated portal with a stopper-shaped head. When a worker wishes to go out into the world she strokes the soldier's back and he moves aside to let her pass, at once plugging the hole with his massive head when she has done so. On her return, the worker strokes the soldier's head with her feelers and he once more steps aside to let her pass.

In striking contrast to these relatively peaceful ants are the slave-making species. These fall naturally into two classes according to their habits. In the first class are those slave-makers which pillage neighbouring nests and carry off the young, as much from a spirit of conquest as from necessity, for they are quite capable of existing, and often do exist, without slaves. In the second class are the ants which without their slaves are quite incapable of looking after themselves. The European slave-maker, of the first class, is a bloodthirsty little beast. It lives under stones, in logs of wood or tree stumps. By many it is considered the most gifted of ants, certainly it is the most war-like, biting all intruders, and injecting acid from the end of its body into the wound thus made. It is capable of making its own nest, securing its own food and rearing its young without the aid of slaves. In fact the enslaved species, when present, only carry out the duties of ordinary workers.

The slave raids take place in July and August, after the nuptial flights of the slave species have taken place. Before a raid, scouts are sent out all over the neighbourhood to spy out the land and to discover favourable nests for attack. The raiders, on the return of the scouts, leave their nests in a straggling open phalanx, or even in several detachments. They move over the ground by the most direct route to their objective, continually shifting their positions in the ranks as they go, some dropping back as stragglers, others coming forward to take their places.

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When they reach the nest to be pillaged they do not attack it at once, but surround it and await the arrival of the other detachments. This is the signal for the other ants to prepare to defend their home, or to seize their young and attempt to break through the encircling cordon. The latter is a false move, for some of the slave-makers snatch away their charges, whilst the others enter and pillage the nest. Soon the raiders return home laden with grubs and chrysalids, whilst the bereft ants slowly enter their pillaged home and take up the nurture of the few remaining young or await the appearance of future broods.

The Amazons, of which there are representatives in Europe and America, never excavate their own nests or care for their young. They are even incapable of obtaining their own food. For the essentials of food, lodging and education they are wholly dependent on the slaves hatched from the worker cocoons they have stolen from alien colonies. Apart from these slaves they are quite unable to live: they even dwell in nests whose architecture throughout is that of the slave species. While in the home nest they sit about in stolid idleness or pass long hours begging the slaves for food or cleaning themselves and burnishing their ruddy armour, but when outside the nest on a predatory expedition they display a dazzling courage and capacity for concerted action compared with which the raids of other ants resemble the clumsy efforts of a lot of untrained militia. And what of the slaves? Are they discontented with their lot? Apparently not, for one of the most extraordinary happenings of the Amazonian raids is the obvious excitement of the stay-at-home slaves when the raiders return with their booty.

CHAPTER IV

TERMITES OR WHITE ANTS

HE would be a churl indeed who failed to admire the work of the early naturalists for, with primitive apparatus and often limited fields of study, they greatly advanced our knowledge of the animal kingdom. Nevertheless, these one-time worthies were anything but happy in their choice of names. Misnomers are as common in the insect world as mites on a seasoned cheese. The insects known as green, dragon or may flies respectively are not flies at all, and there are many still more flagrant misnomers. The common black beetle is neither black nor a beetle white ants are neither white nor are they ants. How white ants earned their name we do not know; probably the fact that they are social insects, living in colonies after the manner of true ants, may have something to do with it. At anyrate, they are not related to the true ants, but to the dragon and may flies. To scientists, sticklers all for accuracy, white ants are known as termites, and that is the name we will use, for it has the merit of brevity, in addition to being more correct.

At the risk of labouring the question of the non-relationship of ants to termites, we will mention one important point of difference. Our readers will remember that we mentioned the great care bestowed by ants on their helpless, footless grubs. Termites, on the other hand, do not pass through all the changes usual to insects; they skip some of the stages and, instead of being grubs unable to fend for themselves, the young ones are as active as their parents, in fact they are miniatures of the adults. Each termite community is made up of winged

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and wingless individuals and of several castes. To each caste a special duty is assigned.

Let us examine one of the giant termite mounds of tropical Africa, Australia, Asia or America and learn for ourselves the marvellous work which is carried on therein, hidden from the outside world. It is in the Tropics that these destructive insects attain their greatest development, both in individual dimensions and in the extent of their colonies. Some of the African termite mounds, exceeding twenty feet in height and measuring over a hundred feet in circumference, house literally millions of inmates. They are composed solely of clay and the saliva of the insects, and by the aid of the tropical sun they become baked as hard as bricks. In outline they are conical and usually consist of one large central cone surrounded by a number of smaller cones.

Although termites are stealthy workers, avoiding the light as a cat shuns water, there is one season of the year when they blacken the air with their presence. This is the time of the nuptial flight, and, as it marks the beginning of a new community, it forms a fitting starting-point for our study of a termite colony. When the nuptial flight takes place, thousands upon thousands of winged termites issue from the dark recesses of their home and fly into the air. Their appearance is the signal for all the insect-eating creatures of the neighbourhood to assemble, for they know by experience that a time of plenty is at hand. Birds, dragon-flies, robber-flies and the like forgather to feast upon the luckless termites. As a consequence few individuals survive their brief flight, taken with the object of pairing, away from their homes. Such, however, is the confusion caused by the advent of voracious enemies that as often as not the insects making their bridal flight are defeated of their object. In any event the flight is never repeated, for although the winged male and female termites which embark on this great adventure are good flyers, when they first come to light

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their wings soon break off short and with the stumps that are left to them they are quite incapable of rising from the ground.

After the nuptial flight the winged females or queens which have escaped the attentions of their enemies seek shelter in the ground and start a new colony. This may be brought about by the queen and her consort, who is known as a king, or, and this is more usual, by the combined efforts of the queen and some individuals from the old colony who join forces with her.

Let us follow the fortunes of the queen and her willing workers. They are all wingless individuals—ordinary workers, nurses, soldiers and, most curious of all, nasuti or nosed ones. The first duty of the ordinary workers is to construct an earthen cell for their queen; this, though termed a royal cell, is merely an oblong chamber of clay, constructed in such a manner that it may be enlarged from time to time. It forms the very centre of the new colony and in it the queen spends the whole of her existence. Her royal palace is also her burial-place. Her whole life is given to the formation of a new colony, she is denied the excitement of the fights in which the soldiers take part, or the distraction of building her home; she cannot even share the work of the nurses who tend her progeny. In solitude she produces her eggs and then, her work accomplished, she dies, and her arduous duties fall upon another younger queen.

Around the royal cell the workers labour unceasingly, day and night, in the construction of hundreds of little chambers, so that in an incredibly short space of time a good-sized structure is formed, with the queen's abode as a centre. Surrounding these small cells there are larger ones connected by passages, and in course of time the home of the termite colony is completed.

During the building operations great changes have been taking place in the appearance of the queen. During and immediately after her nuptial flight she was a slim,

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sprightly individual. The cares of motherhood, however, have wrought wonders in her form and long before her home is completed she increases enormously in size. She becomes so swollen with eggs that she attains dimensions thirty thousand times as great as those of the workers who attend her, yet once she was little bigger than they. So distended is the unfortunate queen by this time that she is quite unable to move ; on this account her internment is not quite the hardship it might appear, in fact it acts as a good and necessary protection for her. She forms a queer-looking object ; her head and legs have not grown and in size "bear about as much relation to the rest of her body as the tuft on his glengarry bonnet bears to a six-foot Highlander." As a consequence they appear hopelessly out of place at the end of her soft, creamy-white, pulpy body, which resembles nothing so much as a young potato. Her attendants are kept constantly busy enlarging her cell to keep pace with her rapidly increasing proportions.

Marvellous as is the rapid growth of the queen, her almost incredible egg-laying capacity is far more extraordinary. Had the fecundity of the queen termite not been proved beyond doubt time and again, it would be unbelievable. She produces eighty thousand eggs a day at the average rate of one a second, and this not for a limited period, for she never slackens her output till she has produced upwards of thirty million eggs.

How comes it that the whole tropical world is not peopled by hosts of termites? They exist in plenty to be sure, but the remarkable fertility of the queens is in line with a well-recognised law of nature that the number of young produced by a female at one time is roughly proportional to the risks the young will run before they are grown up. Animals with few enemies produce but one or two young at a time ; with added risks the number of young increases and attains its zenith with the termites, some other insects and certain fishes. Many of these

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much-persecuted creatures would soon be exterminated were their young numbered even by hundreds.

Thousands upon thousands of individuals never survive the nuptial flight. Nature has wisely made provision for this loss by seeing to it that not only shall the surviving queens produce eggs innumerable, but also by the provision of supplementary queens in each colony. These queens may be likened to the dormant buds of a tree which only develop when the active shoots fail to grow or are destroyed. They are always retained in the colony, though their services may never be required. Should the true queen die, however, they come to the rescue and carry on her work, though to a much more limited extent. In reality they are female workers which are fed in a special manner so that they develop more than their worker sisters, without, however, attaining to the dignity of wings.

After this digression let us turn our attention once again to the royal cell. Its walls are pierced with dozens of holes, through which a constant stream of workers passes unceasingly. Those individuals entering the cell do so empty-handed, or, to be more exact, empty-mouthed; the workers issuing from the cell each bear a single egg in their mouths. With these they scurry off to the small cells surrounding the queen's abode and hand over their burdens to the nurses in waiting. The duties of the nurses are highly specialised; they pack the eggs in the cells in such a manner that they may be freely ventilated; they attend to the temperature and moisture of the surrounding atmosphere, by changing the position of the eggs from time to time, by blocking up the entrances to the cells and by various other devices they contrive to keep the eggs under equable conditions till hatching-time. No incubator was ever tended more carefully. Now their duties are almost at an end, for the young termites are early able to fend for themselves.

During all this time it is hardly likely that the happy

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life of the colony has continued undisturbed. There are many beasts who, with powerful claws and feet, tear down the brick-like walls of the nest and endeavour to feed upon the inmates. Man himself is not altogether guileless, for by certain black races stewed termites are considered a delicacy. When a breach is made in the walls of the nest all the soldiers of the colony are marshalled for its defence. The soldiers, who may easily be distinguished by the enormous development of their heads and jaws, and by the fact that they are quite five times the size of the other workers, hurry off to the scene of the trouble, followed at a respectful distance by the nasuti. Now these termite warriors are absolutely devoid of fear; moreover, they are impelled by a blind fury in their attacks upon their enemies. Blind it is indeed, for, having no eyes, they snap right and left with their powerful jaws, and as often as not their own relatives fall victims to their vicious bites.

When, as frequently happens, the intruder is driven off, the soldiers retire and the nasuti set to work to repair the damaged home. The word nasuti means the nosed ones, and they are so called because of the abnormal elongation of their heads which terminate in a hollow nose-like structure, at the end of which there is a hole whence a fluid passes at the will of the insect. This fluid is used as a glue, to bind the particles of clay together so that they will form a solid mass with the property of rapid hardening. When the work of rebuilding is completed the nasuti assist the ordinary workers in their search for food and in cleaning out the home, for a termite colony is a model of cleanliness.

Different species of termites feed on different substances, as might have been expected, but in certain respects all termites agree. The soldiers of every colony are not averse to making a meal of their brothers, should other food become scarce. True, they usually attack sickly individuals, but healthy ones are not altogether immune



AN ANT-HILL BY DAY

The red wood-ants cover their dwelling with a thatch of leaves and straw or pine-needles, to keep their nurseries and living-rooms warm and dry. During the daytime in fine weather the roof is crowded with busy insects, but at nightfall or when it begins to rain the ants retire within the nest and "shut up house" by closing all the entrances with bits of stick and leaves.

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from their attacks. The other workers bring small pieces of vegetable matter to the nest, and these are chewed up and reduced to a pulp before being eaten. But food from the outside world forms only a small portion of the daily menu. Their own cast skins, regurgitated food and even their excrement form the staple foods of a termite colony. They eat everything eatable ; their excrement is devoured, and greedily too, time and again, till it contains no further nourishment. Small wonder, then, that their nests are models of cleanliness.

When food is scarce and a termite is hungry it will stroke the back of a fellow-worker with its feelers, a proceeding which causes the stroked individual to void partly digested food. This the hungry termite seizes immediately and devours with gusto. For the young, special food is stored after being rolled into balls. This food, which may weigh several pounds in all, is stored in special cells ; it is so hard as to be quite beyond the powers of the young termites' jaws. The nurses, accordingly, come to the rescue and moisten the food masses with their saliva, thereby rendering it soft and palatable.

Allied to, though not very closely related to, the termites are the ant-lions. The adult insects are of little interest, except for their beauty ; with their elongated bodies and lustrous, gauzy wings, they closely resemble dragon-flies. The larva, however, is a totally different being to its active parents. It is as ugly as they are beautiful, as sluggish as they are nimble. Though scarcely able to drag its ill-formed body along the ground by the aid of its feeble legs, it lives upon the most active insects, and its mode of trapping them is truly remarkable. The larva is a thick-set, soft-bodied little creature, armed with a pair of formidable, grooved jaws. Sand is absolutely essential to the insect's welfare, for in sand alone is it able to construct the pitfalls which it uses in the capture of its prey.

Having selected a suitable site, which is probably near

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at hand at the time of its birth, for the ant-lion's eggs are laid in sand, the larva walks round and round in a circle of from one to three inches in diameter. The result of this preliminary manœuvre is the formation of a shallow circular trench which marks the outer boundary of its pit. Having marked out a site, the business of excavating the pit is taken in hand, and the method of doing so is ingenious and peculiar. Travelling in a circle, just within the boundary line, the ant-lion larva scoops up sand with its front legs and piles it upon its flat head. When the load is big enough the creature jerks its head upwards and backwards, thereby throwing its burden to a considerable distance. This delving is continued till the complete circle has been traversed, then it excavates smaller and smaller circles, till finally the pit is completed, and when finished consists of a moderately deep conical hollow in the sand with shelving sides.

At the centre of the pit the ant-lion larva keeps guard, not in full view, as might be expected, but quite buried in the sand, except for its long jaws, which project upwards, opened their widest and ready for immediate use. Sooner or later, and probably sooner than later—for the Tropics, where most of the ant-lions live, are teeming with insect life—an unfortunate insect will pass over the edge of the pit and then its fate is sealed. The sides of the pit are built at such an angle that anything, finding itself upon them, immediately slides down to the bottom, where the fateful jaws are in waiting. When once the larva has seized its prey it never leaves go; it holds on with the tenacity of a bull-dog, meanwhile sucking the life-blood from its victim. Then, with a backward jerk of its head, it casts the carcass well out of the pit and waits for more.

For the capture of small insects, such as ants, no trap could be more cunningly devised than the ant-lion's pit; in the case of larger prey it is not quite so effective. A powerful insect, struggling on the shifting sand slope, will

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make every effort to escape, and in its struggles destroys the pit by gradually filling it up—at least it would do so were it not for the energy displayed by the ant-lion, who, by vigorous upward jerks of its head, throws out the sand almost as quickly as it falls to the bottom of the pit. Few insects escape, for the ant-lion, though slow on its feet, is a tireless digger, and will continue to throw sand from its trap till long after its prospective victim is tired and, through sheer exhaustion, falls back on to the ever-expectant jaws. Frequently in its frantic efforts to clear its pit the ant-lion will hit the struggling insect with one of its loads of sand and thereby bring it tumbling down to be devoured. This little happening has given rise to the popular though erroneous story to the effect that the ant-lion deliberately throws sand at its victim, with the object of knocking it off its feet. After a struggle with an insect large enough to destroy its pit the fastidious owner promptly proceeds to construct another one; no patched-up pit will suffice. When sufficient food has been devoured to enable the larva to go through its last moult and so complete its growth, it buries itself in the sand and changes into a chrysalis within a silken cocoon and a short time afterwards emerges as a shimmering, winged insect.

In this country we have no ant-lions, but we have some very closely allied insects, in the shape of the lacewings, or golden eyes, as they are sometimes called. They are pale green, gauzy-winged little creatures, whilst their larvæ, big-jawed and ferocious-looking, are deadly enemies of all plant lice. The eggs are perhaps better known than either the larvæ or the adults. They are always attached to a leaf blade, preferably one which is attacked by some kind of green-fly. Each egg is stalked and in a cluster, as they are laid; they resemble a group of fairy hat-pins. There is a reason for the stalks. The lacewing larva is a voracious customer, and he would have no scruples about eating the eggs containing his own brothers

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and sisters, but he is frustrated because the succulent eggs are held aloft and out of harm's way by their stalks. The larvæ are rendered more fearsome by reason of their coats of stiff bristles. In some of the foreign lacewings these bristles give place to spines, with which a curious habit of the insects is connected. After a spiny larva has made a meal of an insect—all lacewing larvæ eat insects—the hard, indigestible parts are not thrown away, but are affixed to the spines on the creature's back, so that after several meals every spine bears the remains of a victim. This may be a case of strategy or simply of vanity, the trophies being kept, as a huntsman keeps a fox's brush. In any event, a prosperous larva rapidly becomes so covered with the remains of its repasts that it no longer resembles an insect.

CHAPTER V

WOODWORKERS

THE number of wood-boring insects, the carpenters of the insect world, are legion. One or two of them we have mentioned already. The greatest, most industrious, of all the carpenters are the termites. Their activities render furniture, as we know it, useless in the Tropics. They work furtively, and the results of their work are not apparent till too late, and for this reason. A host of these marauders will attack woodwork during the night to such good purpose—entering rafters, for example, at the ends and hollowing out the interior in an incredibly short time—that eventually nothing but a thin outer shell of wood remains—a shell destined to collapse with the slightest strain. The only bright spot in this sordid story is that certain woods, such as teak and various resinous timbers, are left severely alone by these insects.

In Britain we have an excellent though destructive carpenter in the shape of the goat-moth larva ; so called on account of the nauseating goat-like smell which it gives off. The female moth, a large, heavy, grey-coloured creature, lays her eggs in cracks on the bark of some tree, preferably a willow. She usually chooses a spot not very far from the ground. The larvæ, when they emerge, waste no time in tunnelling into the tree, through the bark to the wood beneath. Needless to add that, even at this early stage of their existence, they possess inordinately powerful jaws and, in addition, they give off a fluid from their mouths which is supposed to have the power of rendering the wood soft and more easily worked.

To give some idea of the life work of these caterpillars

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we may mention that they go on tunnelling in the tree for three years, and during this time each one increases in weight seventy-two thousand times ! Small wonder then that the goat-moth is looked upon with great disfavour by foresters. At the end of three years the larvæ are fully fed and are, withal, repulsive-looking creatures. In colour, they resemble boiled prawns somewhat ; in odour, the rankest billy-goat, a failing which renders them undesirable as pets, but that is not their only drawback. Their wood-boring propensities are liable to lead to unpleasant consequences. We once knew of an enthusiastic young entomologist who brought home a couple of these larvæ in a cardboard box and deposited them for the night on the family grand piano. In the morning the box was empty and the caterpillars were in the piano ; furthermore, they had entered by the shortest route, boring holes right through the rosewood case. Nothing short of a tin box will prevent these larvæ from straying and possibly damaging furniture.

The fully fed larva constructs a very ingenious cocoon. Inside it is smoothly and snugly lined with silk ; outside it is armour-plated by means of a mixture of wood-shavings and saliva. Comfortable and warm within, yet secure in his armoured cocoon, the goat-moth undergoes the changes which convert him from a fat and juicy caterpillar to a large smoke-coloured moth.

The mention of furniture calls to mind another humble carpenter, in the shape of the death-watch, a beetle which causes so-called worm-eaten wood. The popular name of this beetle may occasion some curiosity. The beetle maintains an intermittent tattoo on the sides of its burrow in the wood. These taps were, and are still in some parts of the country, thought to presage death ; those who are not superstitious will not cavil at a more matter of fact, if less romantic, explanation : they are simply the calls of the female to her mate, the wireless telegraphy of the death-watch. Five times she taps rapidly by knocking

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her head against the end of her burrow in the wood, and awaits an answering tattoo.

Here let us relate an interesting little story. One of these beetles was made captive in a small glass-topped box, and captivity did not impair its amorous nature. Five taps, on the lid of the box, with a pencil or a similar object, elicited a similar number of taps in reply. Six taps, or four, brought forth no response. Now it has been alleged that the taps are not actually heard by the beetles, but are simply communicated from one to the other by the vibrations of the wood when it is tapped. The little box, therefore, with its inmate, was suspended by a string to the ceiling. Taps on a table below were still answered by the beetle in its aerial prison, thus settling once and for all the question of its hearing powers. The last performance of this beetle was a triumph. Its performance was exhibited before the members of a well-known society. It gave a stirring performance, which raised the audience to a high pitch of excitement—the members were all entomologists and therefore easily amused—applause greeted the beetle's efforts, at the end of its "turn," but the beetle, not to be outdone, answered the applause with a series of taps, a feat which wellnigh overcame the afore-said entomologists.

But we have digressed. The death-watch bores into timber, our most valued furniture for choice, making little holes therein resembling shot holes. When within the wood, boring operations are carried out with considerable energy, and the female deposits her eggs at the end of each tunnel. The white grubs which hatch from these eggs are armed with strong jaws, enabling them also to carry on the woodwork of their parents. Within the burrows the chrysalids are formed, and the following season a new generation of beetles arises to carry on the work of destruction and scare some country bumpkins with their taps.

Certain wood-boring beetles, popularly termed *Ambrosia*

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beetles, not only display considerable ingenuity in the construction of their homes but are possessed of maternal instincts foreign to most insects. In the spring, the season when the thoughts of most animals are turned towards parental duties, the mother Ambrosia beetles seek out a suitable tree for their operations. Into this tree they bore a horizontal tunnel, which in a short distance is diverted vertically. The sawdust formed in the tunnelling operations is for the most part pushed backwards through the tunnel, and trickles in a fine stream down the tree trunk—a certain indication that work is going on within.

On the completion of the first vertical tunnel the mother beetle deposits a group of six eggs at its extremity and closes the entrance with a little plug of damp sawdust; more vertical tunnels are made, and eggs are deposited therein, and they are plugged in exactly the same manner. Often the mother beetle will make nearly fifty of these tunnels, with the result that those first formed contain larvæ long before she has finished her labours, for the eggs hatch in a few days. Now these larvæ, unlike those of the death-watch, have very feeble jaws, quite incapable of biting wood.

A most wonderful Providence watches over the youngsters, and in this manner. We mentioned that at the entrance to every side tunnel the mother beetle placed a plug of damp sawdust; these plugs are so many doors to so many rooms, all opening into a long passage, the horizontal tunnel. As the operations of boring and egg-laying are going on, the long passage, into which the side doors open, becomes filled with a dark coloured fungus, a fungus upon which the larval beetles feed. As soon as a batch of eggs hatches, the mother beetle removes the plug of sawdust, opens the door of the side chamber, and the inmates are free to browse upon their fungus fare.

How does the fungus find its way into the tunnel? It is placed there by the far-seeing mother beetle. As the work of tunnelling proceeds, sap oozes from the sides of

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the chambers; the sap forms excellent material on which to grow the fungus, so the mother beetle brings to her home a few fungus spores (spores of fungi may be compared to seeds of flowering plants) and places them on the sappy wood, with the result that in an incredibly short time there is a growth ample for all her needs. When the grubs are fully fed they change into chrysalids and, eventually, into adult beetles in the tunnels, and there they spend the winter. In the following spring they mate, the future mothers swallow some of the fungus spores and seek fresh spots for their woodworking operations. The skins of the spores are exceedingly tough, and should the need arise they will remain in the gizzard of the Ambrosia beetle for nearly three months without suffering any damage.

The Cigarette beetle is a little insect of fastidious tastes; though not strictly speaking a wood-borer, he may safely be included here. Though diminutive, he is capable of doing considerable damage. The mother beetle lays her eggs, one at a time, either on the tobacco leaf or just within the open end of a cigar or cigarette, but she does not do so at haphazard, for she is something of a connoisseur; she selects Claros rather than Maduras, Turkish tobacco by preference to shag. The larvæ hatch in about a week, and tunnel in all directions, rendering the tobacco useless. Cigars and cigarettes become so riddled with holes that they will not "draw."

The little beetle is, however, catholic in its tastes and, failing tobacco, will bore into and breed in or amongst raisins, belladonna, ginger, rice, dried fish, turmeric, rhubarb, cayenne pepper, books, canned goods, cartridge wads, liquorice, saffron and in pyrethrum powders strong enough to kill any other insect. Certain moth larvæ will bore and tunnel into wine corks to such an extent that the wine either runs out of the bottles in which the corks are situate or turns sour.

Hosts of beetle and moth larvæ either bore into biscuits,

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cereals or other seeds, or at least so damage them that they are rendered unfit for consumption. But let us return to the true insect carpenters.

A relative of the goat-moth, one of our most beautiful British insects, the wood-leopard moth is in its larvæ stage an industrious carpenter. A handsome cream-coloured moth, decorated with spots and splashes of steel-blue, it is a common object of our country-side. The female lays her eggs on or near the tips of the small branches of some favoured tree—the apple is commonly selected—and the caterpillars, when they emerge, bore into the centres of the twigs and eat away the pith. They are long-lived and eat the whole time, with the result that the twigs they have favoured with their attentions wither and die. Like its cousin the goat-moth, this insect makes for itself a silk-lined armoured cocoon.

The clearwing-moths, which mimic wasps and hornets, have similar habits, but they display an amount of ingenuity which is lacking in the wood-leopard moth. Their larvæ bore into the pith of certain trees, but when they are fully fed, instead of building reinforced cocoons, they work their way almost to the outside of the branch in which they have lived, just before they change into chrysalids. So nearly do they travel to the exterior that but the thinnest tissue of wood separates them from the air. Settling down with their heads towards the outside of the tree, they change into chrysalids, which are armed with backwardly directed spines. When the moths are about to emerge, the chrysalids, by means of these spines, push their way outwards, break the thin shell of wood, and pass half-way out of the end of their burrow. When the moths escape, the empty chrysalid cases project from the tree.

Concerning these larvæ, an entomologist once wrote: "We observed about a dozen of them during this summer, in the trunk of a poplar, one side of which had been stripped of its bark. It was this portion of the trunk

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which all the caterpillars selected for their final retreat, not one being observed where the tree was covered with bark. The ingenuity of the little architects consisted in scraping the cell almost to the very surface of the wood, as thin as writing-paper. Previous, therefore, to the chrysalis making its way through the feeble barrier, it could not have been suspected that an insect was lodged under the smooth wood. We observed more than one of these insects in the act of breaking through this covering, within which there is besides a round movable lid, a sort of brown wax."

Beetles of various other kinds are notorious carpenters ; it would, however, require a good-sized volume to describe them and their doings.

Before we leave the wood-borers and devote our space to woodworkers of another kind, we must mention an insect which, though absolutely harmless to human beings, never fails, by reason of its formidable appearance, to arouse a considerable amount of apprehension in the minds of those who look on it for the first time ; we refer to the giant wood-wasp. The female, which measures about an inch and a half, is banded with yellow and black and of wasp-like appearance ; at the end of its body is a formidable-looking instrument which is usually mistaken for a sting ; as a matter of fact it is simply the apparatus, called an ovipositor, with which the female bores a hole in wood, that she may lay her eggs in its tissues.

Felled or sickly fir-trees are favoured by the wood-wasps ; the female bores a hole through the bark with her awl-like ovipositor and lays her eggs in the wood. The larvæ, when they hatch, tunnel in all directions, eating away the wood as they go. It passes through their bodies and plugs up the part of the tunnel which has been traversed, so that the larvæ always dwell in a closed chamber. There seems to be some doubt concerning the eventual career of the insect. Some authorities aver that the grub tunnels almost to the surface of the tree before

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it changes into a chrysalis, after the manner of the clearwing-moths; others aver that the change takes place in the heart of the tree and that the perfect insects eat their way out. That they are capable of doing so there can be no doubt, for they can eat through lead-sheeting.

In America, where, by the way, these insects are called horn-tails, one species displays considerable ingenuity. The female deposits her eggs in willow branches, and, after doing so, she girdles the tree—that is, removes a ring of bark—and in this manner prevents the further growth of the wood which might conceivably crush her progeny.

In a well-ordered scheme of nature it is fitting to ask: Of what use are these destructive insects? Well, when they first came upon the earth there were no such things as houses and furniture, and in those days the insect carpenters did good. Concerning them an eminent entomologist said: "Probably no portion of the world contains a larger number than the densely timbered Amazon basin. In these great forests the Longicornia [long-horned beetles] play a very important part in the economy of nature. As soon as a tree dies and begins to decay, their larvæ, which are often of great size, attack it and bore it through and through; the work of boring from their larger galleries is then taken up by various smaller species of wood-boring beetles and free access is then given to the rain and moisture which soon reduce the trunks to a pulp and cause them not only to disappear, but to act as manure to those trees that take their place."

The second class of wood artificers with which we are concerned are the gall-makers. Like the wood-borers, they are of many species, and their galls are as varied as their kinds. The resin-moth is a peculiar gall-maker which takes advantage of the fact that cone-bearing trees, when injured, give off resins freely. The female lays her eggs at the tip of some fir-tree, and when the caterpillars hatch they bite into the wood, thus causing the resin to flow. The ingenious little insects put the sticky substance to good

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use. They so mould and work it that it forms a good sized double-chambered shelter, in one compartment of which they live and in the other place their excrement and waste food. But the resin-moth is not a true gall-maker.

There are real galls in plenty, so let us search for them ; the nearest oak-tree, or, failing that, a willow or rose bush, will probably supply all we need. The oak, however, is the tree for galls ; it bristles with them ; oak apples, spangle, currant, kidney, and artichoke galls are a few picked at random. These galls were familiar objects long before it was known that they were the work of insects, and this is hardly surprising, for the galls are conspicuous, the gall insects minute.

Before considering any gall in detail, let us try to learn something of general gall formation. We will therefore, in imagination, watch a female gall insect at work ; luck and a convenient oak leaf will supply our need, and luck is an essential. When the insect settles on the leaf we must watch her through a pocket lens, for she is too small to observe with the naked eye. She wanders hither and thither on the leaf, and her movements are by no means easy to follow.

At length she calls a halt on a small leaf vein, and this is the opportunity we have awaited. From the end of her body a long, fine, thread-like structure is unfolded. It is her ovipositor, and she loses no time in plunging it deeply into the tissue of the leaf. A puncture made, the single egg passes down her ovipositor and is placed in position within the leaf. Following the egg comes a drop of fluid whose purpose was for long misunderstood. The fluid was thought to be the cause of the gall ; as a matter of fact, it is merely used to heal the wound made by the female gall insect. The gall or swelling on the plant may assume the most varied and remarkable shapes, and one fact we must never lose sight of is this, the same species of insect always produces the same kind of gall ;

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the insect responsible for the oak apple can never produce a spangle gall, any more than the insect which produces the robin's pincushion on the rose can make the pea gall on the same plant.

The Bedeguar, or robin's pincushion of the rose, is one of our commonest galls; the bright red woolly growths are familiar objects of our country lanes. The female gall insect lays its eggs in the stem of the rose, so that they come in contact with the cambium. Now the cambium is the part of the plant which forms the new tissue and is very susceptible to any irritant. So long as the gall insect remains in the egg stage no gall is formed; but with the hatching of the egg, the malformation, for a gall is nothing more or less, begins to grow. And the cause—possibly the constant gnawing of the little grub, probably some irritant substance which it gives off from its body, or, very likely, both combined. This particular gall differs from most others in that it contains several larvæ instead of a single one, as is usually the case. As these larvæ develop, the well-known red pincushions come into being. Their woolly outgrowths are really malformed leaves, the best that the plant can do under the circumstances.

We will devote our time to a study of the oak which will supply us with one of the romances of insect life. The objects of our investigation for the moment are the common spangle and currant galls. The former are to be found on the under side of the oak leaves about July; the latter hang from the catkins or leaves early in the year. We have said that the same species of gall insect always produces the same kind of gall; the insect producing spangle galls is of the same kind as the one producing currant galls: are we then guilty of a "terminological inexactitude"? By no means, for these particular gall insects provide examples of a very wonderful phenomenon known as alternation of generations.

We have studiously tried to avoid wearying or perplexing our readers with technicalities or abstruse theories, but

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here we are up against a problem on which we feel that we are justified in letting ourselves go a little, for the whole subject is of such absorbing interest that we shall probably be forgiven for our lapse. The spangle galls somewhat resemble the collections of spores, called sori, to be found on the backs of fern fronds; they are lens-shaped and hairy; they vary in colour from pale yellow to deep brown. Towards autumn the oak leaves fall and the spangle galls with them; in each gall there is a gall insect larva. During late autumn the rains cause the galls to swell and increase in size considerably, but the larva within continues to feed, paying no heed to frost and snow and rain, for it is well protected from the elements. In the spring the insect changes into a chrysalis, and emerges as an adult insect a little later.

Each and every insect coming from a spangle gall is a female; no males have ever been discovered. Unless, therefore, Nature came to the rescue, this race of gall insects would soon die out. This is not to be, for these females can reproduce their kind without the help of a male, a feat which is not uncommon in the insect world. The females from the spangle galls are provided with very long ovipositors, and they waste no time in plunging them deep into a dormant oak bud and depositing their eggs on the as yet undeveloped catkins, or sometimes on the leaves. As the bud develops the catkins elongate and are seen to bear one or more round growths about the size of a currant, green at first but ripening later to a bright red colour, thus still more closely resembling the fruits from which they derive their name. About May the adult insects emerge from their galls, and they are both males and females, the latter differing from their sisters of the spangle-gall generation in many respects, notably by the absence of a long ovipositor, which would be useless, seeing that they lay their eggs just below the skin at the back of an oak leaf—eggs that are destined to form larvæ causing spangle galls.

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Small wonder then that these gall insects received different scientific names before it was shown that they were merely different generations of one and the same insect. The case of the oak apple is nearly as strange. Long before the winter has left us the little gall-wasp, maker of this well-known gall, is hard at work. She lays her eggs in the end buds of the oak branches, first of all boring a hole and then depositing her eggs therein.

A well-known entomologist once observed the work of one of these insects. "When it had finished its first bud," he wrote, "it went on, without interruption, to another, and was altogether eighty-seven hours busily employed in laying eggs." In these two buds, five hundred and eighty-two eggs were counted. Early in May the galls begin to grow, and four short weeks later they are fully developed, being soft and of a greenish-yellow colour. As the oak apples grow they turn rose-coloured, and shortly after this change winged males and wingless females bore their respective ways from the galls. These females are smaller than the individuals which produced them—their mothers—and, after mating, they pass down the trunk of the oak-tree, penetrate the soil and deposit their eggs in the roots, causing hard, brown, spherical galls to be formed. From those galls, pale brown, wingless females emerge; they push their way through the soil, travel up the trunk, thereby running the gauntlet of tits, nuthatches and tree creepers, ever on the alert for insect fare, till at length they reach the end buds of the tree and, laying their eggs therein, the life cycle begins anew. It is interesting to note that the oak apples which are formed in spring, when the trees are full of sap, are themselves sappy; the root galls, formed in autumn, when there is little sap in the trees, are quite hard and effectually protect the larvæ within from frost, during the long winter months.

The marble gall of the oak, commonest of all galls and often wrongly called the oak apple, is still a mystery, for nothing but female gall insects have ever been discovered.

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Is this a case of alternation of generations in which only one generation has as yet been discovered? Is it, on the other hand, a rare example of a race of females which, from year's end to year's end, throughout the ages, can reproduce their kind without the aid of males? It may be so, but it seems unlikely. Perhaps some reader of this page may one day solve the problem—who knows?

One of the most ingenious galls is the pine-apple gall found on the spruce. The cause of this curious gall is a bug. Towards autumn the larvæ which are destined to produce the galls travel to the bases of the spruce shoots, and there they dig their beaks deep in the tissues of the tree. Being bugs, they are all armed with sharp, pointed beaks, and by these means they remain suspended from and attached to a shoot till spring. During the winter no change takes place in the host tree, and the young bugs take no nourishment from it. With the advent of spring, each individual, its beak still buried in the plant tissue, begins to suck the juices of the tree, and then and then only the pine-apple gall begins to be formed.

Without illustrative figures it is by no means easy to make quite clear the changes which take place during the formation of the gall. At any rate the bases of the leaves begin to swell and, as they are situated close to one another, they gradually fuse to form the gall; but at the same time some little space is left at their outer sides, so that the result is the formation of a swollen portion of the stem in which there are a number of little cavities, represented by the spaces between the leaves.

As the aphides grow, for such are these gall insects, they cover themselves with a white, waxy, woolly substance, which affords them some protection. About a month after the beginning of the gall formation the aphides begin to lay their eggs, an operation they continue to perform for about six weeks, and each egg is attached to the spruce twig by a thread-like stalk. The larvæ emerge, just about the time the cavities between the leaves of the

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gall are ready for occupation, "a perfection of adjustment which excites our deepest admiration." The larvæ crawl into the spaces between the already malformed leaves and begin to feed by sucking the plant juices with their beaks, just as their parents did.

The feeding of the larvæ causes further abnormal growth in the gall, with the result that it grows still more and, in doing so, completely shuts in the larvæ, and the "pine-apple" is formed. In each cavity there may be as many as fifty larvæ, and the whole gall may house two thousand larvæ. Late in the summer the larvæ stop feeding and the growth of the gall ceases; so that at the end of each cavity, where the larvæ lie hidden, a small hole is formed, through which the pupæ escape and turn into winged females. These individuals lay their eggs at the bases of the leaf buds and the life cycle begins anew.

CHAPTER VI

LARVÆ AND THEIR WORK

IT is hardly surprising that insect larvæ should display so much ingenuity in the means they employ to protect themselves from injury. For the most part they are thin-skinned, plump-bodied individuals, and so form appetising fare for parasitic and predatory enemies. They are entirely dependent on their own resources; maternal care is unknown in the insect world, except in the earwigs, one species of sawfly and the wood-boring beetle we have just mentioned. We shall have something to say concerning protective colouring and mimicry in a later chapter, and although these devices must certainly be included in any account of the means of self-preservation adopted by immature insects, we now wish to say a word or two concerning the little buildings constructed by various larvæ, in which they may hide, using them either as lairs for the capture of living creatures likely to make succulent meals, or as homes in which they may live and feed without molestation.

In the former class we must certainly place the larva of the tiger-beetle. Many of the tiger-beetles are noteworthy on account of their beautiful colouring, charmingly iridescent metallic green and blues predominating. Long-legged creatures, the adult beetles can race along the ground at an incredible speed, an accomplishment which stands them in good stead, for they obtain their livelihood by hunting. Curiously enough, the larva is also a flesh-eating individual, but owing to his build he is quite unable to pursue his prey after the manner of his parents. That, however, does not upset him, for his methods are equally efficacious and less laborious. His first and only home is

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in the ground ; he hatches from an egg laid in the soil by the mother beetle.

A curious, almost repulsive, creature is the tiger-beetle larva. Nearly at the centre of his body there is a peculiar kink, so that his outline is, roughly, that of the figure 3. His head is massive, horny and flattened, and it serves him well for more than one purpose. In early life he uses his hard, flat head as a hod on which to carry the earth from the spot where he hatched to the surface of the ground, and thus he forms his burrow. This subterranean home may be more than a foot in length, and is perfectly vertical. On the completion of the excavation the creature's head serves another purpose : it acts as a stopper for the burrow. Thus, at the open end of its earthen home, the larva will await its living meal for hours on end. Any insect passing near its formidable jaws is seized and drawn into the burrow, to be devoured at leisure.

There is one most interesting point in connection with this larva which we have not mentioned. We remarked that its outline is that of a figure 3 ; well, on the hinder end of the creature's back—that is, on the outer edge of the lower loop—there are a pair of sharp hooks which serve a useful purpose. By their means the larva hooks itself into position at the mouth of its burrow ; when any prey is caught, the hooks are released and the larva, with its victim, drops to the bottom of its lair, like the proverbial streak of lightning. The home of the tiger-beetle larva is indeed a simple structure compared with some of the constructions built by other larvæ.

Some of the caddis-fly larvæ, like those of the tiger-beetle, are flesh-eaters ; they also construct lairs, but they live in water and not in the ground. The homes of these water-dwellers are so diverse that we cannot describe them all in detail. Two species cut green leaves into almost rectangular pieces and fasten their edges together, so as to form complete tubular or rectangular mantles, as

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the case may be. Another common species places short lengths of stick transversely across one another, and fastens them together to form its spiky home. A third constructs a house of small shells, some of which still contain their owners who are carried about willy-nilly by the caddis larva. Still another builds a tube of fine sand.

As this list could be continued to considerable lengths, let us mention a little point of interest before describing two of the most extraordinary larval houses to be found amongst these adept house-builders. The caddis larva must needs be something of an engineer, or should we say a physicist, as well as a builder. His home must be light enough to be moved freely from place to place, yet not so light that it will float in water. An examination of a few of these larval cases will show some which are absolutely ruined from an architectural point of view.

Beautifully built, in the main, of sticks, or shells, or pebbles, or sand, or whatever material is most favoured by the particular kind of larva, each item in the structure being of approximately the same size as all the others, yet the whole appearance of the case is spoiled by the fact that a large pebble or shell is affixed to one side of the case. These eyesores are not without their uses: they serve as ballast for the caddis home; they prevent the little building from floating to the surface of the water.

And now for the more ingenious caddis dwellings. There is one kind of larva which, forsaking the conventional tubular case, builds one of sand exactly like a snail shell in appearance. So close is the resemblance between the homes of these two quite unrelated creatures that the caddis dwelling for long puzzled naturalists, one of whom actually described it as a new kind of snail. Curiously enough, the home of a minute marine worm closely mimics a snail shell; this little creature is often found in hundreds attached to the common bladder wrack.

The second dwelling we are about to describe is more ingenious though no more curious. Everyone has either

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seen the decoys used for the capture of wild-duck in the fen country, or at any rate pictures of them. These traps consist of nets arranged to form a long tube, spread wide at the mouth and gradually tapering off into quite a narrow tunnel. The ducks are lured into the large open end and driven up into the narrow part, where they are caught.

Whether man reaped his idea for this novel form of trap from the caddis-flies we cannot say, but it is a fact that one kind of caddis larva builds a home which is an exact replica in miniature of a fenland duck decoy. The open end of this funnel-shaped dwelling is composed of strong silk netting, held in position by a few arched twigs; in the narrow end of the funnel the larva lurks. The mouth of the dwelling always faces up-stream, in order that water insects may be carried down into it; there they are seized and devoured by the larva.

No one watching some free flying moth disporting itself on the evening air would ever suspect that the larvæ of some of these children of the night live in water and, what is more, construct larval cases rivalling those of the caddis-flies. One of these insects, the brown china-marks moth, deposits its eggs on the under sides of water-lily leaves and covers them with a jelly-like covering. By the way, this habit of many water-dwelling animals of covering their eggs with jelly is not without its uses: the jelly protects the eggs from injury by hungry fishes. The first act of the caterpillars, when they hatch from the eggs, is to build a home for themselves. This they do by cutting two neat little oval-shaped pieces from the leaf surface and binding their edges together with silk, so as to form a lens-shaped shelter. The small china-marks moth lays its eggs on duckweed, a well-known floating water plant. The larva spins together a number of the round duckweed leaves with silk and builds a tubular case, remarkably like the cases of some caddis-fly larvæ.

A very curious little creature is a leaf-eating beetle of aquatic habits. The female eats circular holes in the

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floating leaves of water-lily and deposits her eggs either in a single or double row around the hole, and on the under side of the leaf. The larvæ feed on the water-lily roots, spending all their time below water; they have no gills nor other organs to fit them for such a life, for which they appear ill adapted. The manner in which these larvæ obtain air is ingenious in the extreme.

Now water plants differ from land plants in that they have large air-spaces enclosed in their tissues, and this enclosed air is stolen by our little insect. On the hinder end of his back there are two curved spines which are connected with breathing tubes. Naturalists noticed that the roots frequented by these larvæ bore sundry slits and scars, always at about the same distance from one another, and the distance was the length of a larva. Further investigation showed that the cute little creature inserted its spines into the roots of the water-lily and pushed them home till they reached the air-spaces within; it literally tapped the roots of air. The cocoon of this insect is no less ingenious. It is a close-woven silken structure closely applied to the root, but on the side which is in contact with the plant there is no silken wall. The outside of the root forms the wall and is punctured with many holes through which air passes to the chrysalis.

Another point worthy of mention is that, as a rule, wounds on these roots quickly heal, a happening that would be fatal to the chrysalis, seeing that it is quite unable to keep the air-holes open. By one of those provisions of which Nature shows so many examples, the wounds, in this case, do not heal till the cocoon is either removed or destroyed, till water is allowed to enter, in other words.

There are other case-makers which we must consider, land case-makers though. The bag worms, of which some of the finest examples are found in Australia, build larva cases nearly as diverse in structure as are the cases of the various caddis-flies. Most of these cases are built of small sticks,

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laid transversely one on the other and bound together with silk so that the whole structure forms a tube; in other species the sticks are laid longitudinally, but whatever the plan, the peculiarity which cannot fail to strike an observer is the remarkable uniformity in the length of the sticks used in building the home. Within its case the larva dwells and feeds contentedly on the leaves of its favourite food-plant, probably a wattle; should danger threaten, the insect simply withdraws into its shell after the manner of a tortoise and remains in hiding till the danger be passed.

Equally ingenious, but less obvious on account of their small size, are the cases of the clothes-moth caterpillars. The mother moth lays her eggs on some fabric, wool or fur for choice, and in due course the little house-building larva emerges therefrom. For the construction of its dwelling, the creature makes use of the nap of the cloth on which it is hatched; from this material it builds a tubular cell which is just long enough to conceal its body. The diminutive tube is wider at the centre than at either end, and purposely so, for the following reason. As the caterpillar feeds, which, by the way, it does on the body of the cloth and not on the nap, it grows and eventually becomes too large for its home.

Now when the caddis-fly larvæ are too long for their cases they simply build others of suitable size; not so the clothes-moth larva, which enlarges his original home to suit his needs, and in order to do so it is necessary to be able to turn round, hence the larger size of the tube towards the centre. When it is necessary to start rebuilding operations, the larva cuts a triangular piece from his tube, opens wide the cut ends and proceeds to fill up the space thus formed with new material. Then he turns round and repeats the operation at the other end. Should the tube be too short, material is added to either end in rings. The whole operation is completed without the larva leaving the shelter of its home. By moving a young

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clothes-moth caterpillar from material of one colour to that of another during his growth, he will end up with a home rivalling Joseph's coat ; for with each reconstruction he will insert material of another colour to those already used.

Certain insects make cases of leaves—living leaves and not snippets cut from a leaf. By one of Nature's inexplicable vagaries, very small insects nearly always build their cases of very large leaves and the means they adopt to overcome their difficulties are ingenious in the extreme. Of these "leaf-rollers," as they are called, one of the most interesting is the birch weevil. The female of this little beetle is too small to deal with a whole birch leaf, but she is nothing daunted by that. Selecting a point on the leaf margin nearly midway between leaf stalk and tip, she cuts a way from margin to midrib and repeats the operation on the opposite side, so that the leaf is cut in two, except for the midrib, which is left undamaged.

The next proceeding consists in rolling inwards the edges of the leaf nearest to the tip till they form a tube and the whole structure has the appearance of a small leaf whose tip is elongated and formed into the shape of a cylinder. The labours of the beetle, however, are not yet completed. The leafy home is destined to form a shelter for eggs and larvæ and, in its present state, would permit its living contents to fall out at the end. The beetle, therefore, by the aid of legs and head, tucks in the tip of the leaf to form an end to its cylinder, much as a grocer tucks in the paper of the cones in which he sells his sugar.

A weevil, no larger than the birch weevil, constructs its larval shelter of the poplar leaves on which it dwells. This little beetle, though industrious, patient and, for its size, strong, is yet far too weak to deal with the relatively large leaf of the poplar-tree : a leaf which is far less pliable than the birch leaf. The ingenuity displayed by this beetle to overcome its difficulty is little short of marvellous.

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The living leaf is too strong and lengthy to deal with ; a dead leaf would be equally useless to the beetle, for it would be wiry yet brittle. The object of the beetle, therefore, is to obtain a wilted leaf, for in that condition it may be rolled far more easily. The insect, therefore, makes a minute puncture in the leaf stalk, not through the skin alone, but into the parts of the leaf which are bringing nourishment thereto from the stem. This operation causes the leaf to become soft without killing it : brings it, in fact, to the very condition desired by the beetle. Next the industrious little creature, beginning at one edge, rolls the leaf lengthways. Using her feet for the purpose, she holds on to the leaf blade firmly with those on one side and rolls the leaf neatly with those on the other. The task is a laborious one ; her hold on the leaf must never be relaxed or it would fly back like a watch-spring. Methodically she works. As she rolls the leaf she travels from one end to the other ; then, without turning round, she moves backwards, continuing her rolling all the time, a little living shuttle. When the leaf blade is rolled to the midrib, the beetle rolls the other half of the leaf round the portion already rolled, and eventually her labours are at an end, or nearly so.

When a neat cylinder has been rolled, the structure of the leaf comes to the insect's aid. On its margin there are a number of minute glands which give off a sticky substance. These marginal glands are firmly pressed into contact with the body of the leaf by the beetle, who uses her snout for the purpose. The sticky secretion forms an excellent glue, and the leaf edge remains in position. In the cylinder, the beetle deposits one or more eggs, secure in the knowledge that its larvæ will be able to feed without fear of molestation.

The caterpillars of the oak tortrix moth are leaf-rollers which go about their business in quite a different manner from the insects we have just mentioned. They are partial to oak leaves. Though they build some remarkably

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ingenious shelters, they do not exhibit such wonderful uniformity of architecture as the beetles. Another point of difference is that the beetle larvæ remain in their leafy shelters, come what may, but the caterpillars of the leaf-rolling moths, or, more correctly, the leaf-rolling caterpillars, when alarmed, leave their hiding-places and hang from the leaves by silken threads which they spin themselves, only returning to their shelters when the danger be over. Whatever surprise we may have felt that a creature so small as the birch weevil could roll a birch leaf must be intensified when we consider how it is possible for the oft-times exceedingly diminutive leaf-rolling caterpillars to mould a living leaf to suit their purpose. These little individuals perform some astounding engineering feats. Let us see how they work.

Diligent search on the part of the caterpillar has its reward in the discovery of a leaf which is, maybe, ever so slightly curved. Such a leaf makes a good starting-point for the little engineer, whose first care is to run a number of silken threads from the curved margin of the leaf to a point as far as it can reach on the leaf blade. This preliminary structure may be looked upon as a kind of scaffolding from which the more useful part of the work may be undertaken, for these first threads do not cause the leaf to roll any more. Having spun a sufficiency of silk for its purpose, the caterpillar climbs upon them and, by pressing thereon, sets up a tension which causes the leaf margin to be drawn a little nearer to the blade, ever so little nearer certainly, but sufficient for the engineer's purpose.

Now the larva repeats its spinning operations, fixing its new threads as far over on the convex side of the leaf curl as possible and as far towards the centre of the leaf as it can reach. From side to side the industrious little creature's head waves as it spins, till at length it finishes its system of stay ropes and the leaf has been pulled over a shade more. The operation is repeated again and

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again; and each time the leaf becomes slightly more curled. At length, after many hours' work, during which the larva has scarcely ever cried a halt, the leaf is rolled and the caterpillar seeks a well-deserved rest within its newly built home. So common are these rolled leaves, we pass them by unnoticed every summer in their hundreds of thousands, yet each leaf represents the result of the untiring labours of a clever and industrious little insect.

Equally common in our hedgerows is the home of the "cuckoo spit" insect, or "frog-hopper." The larva frog-hopper, unable to escape its enemies by a series of gigantic leaps, like its parents, must needs have some protection. He cannot build a leaf shelter, he cannot roll leaves nor burrow into the ground, but he has a big appetite and he puts it to good use, or would do so if certain clever birds had not found him out. Related to the green-flies, he, like them, possesses an awl-like mouth, which he digs into plant stems and sucks sap therefrom in quantity. Much of this sap he ejects in the form of a somewhat sticky, clear liquid; having done so, he wags his tail so violently that the liquid is beaten up into a froth which completely covers him; it is, in fact, the well-known cuckoo spit. If left alone the larva would develop into a full-grown frog-hopper within his hiding-place, but certain birds have seen through his subterfuge and rudely pluck him from his shelter, to his discomfort. The leaf-rollers have their counterpart in the leaf-miners, which may be the larvæ either of moths, beetles, or flies, the first-named being the commonest.

The least observant among us must have seen some mined leaves. Roses, celery, thistles and oak are amongst the plants whose leaves are most frequently mined. It will be easier to understand how these little insects work if we know something of the general structure of a leaf. In very non-technical language, each leaf may be looked upon as a kind of sandwich, with soft green vegetable matter between an upper and lower parchment-

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like skin. Now the leaf-miners are very ingeniously protected from their enemies, and that without the least effort on their own part. The mother moth, beetle or fly lays her eggs either on, or just below, the surface of the leaf skin, and directly the caterpillar hatches it makes a hole through the skin, if its mother has not already done so, and proceeds to feed upon the luscious green food below. It walks as it feeds, so that before long a sinuous tunnel is excavated in the leaf, resembling a winding river on a map.

The farther the caterpillar winds its way, the wider the tunnel becomes, for as the insect grows it naturally requires more and more room. Accordingly it eats away more of the green part of the leaf. By the time the insect is ready to turn into a chrysalis its leafy burrow is of a considerable length. At its termination the change into a chrysalis takes place and the perfect insect eats its way to freedom at a later date. What an elysian existence! Food in plenty and absolute protection from enemies and the elements, for the leaf skin prevents any harm coming to the caterpillar short of a pinch from human fingers.

All the larvæ we have described so far live lonely lives apart from their fellows. There are certain caterpillars which club together for mutual protection; not, be it said, in recognised social communities, as the bees and ants, but in simple herding together for safety's sake. These larvæ are known as tent caterpillars, because they construct silken tents of remarkably tough material, beneath which they take shelter in time of danger. It is wellnigh impossible to relate the shape of any of these tents, say the one constructed by the small ermine moth larvæ. They are simply sheets of silk, woven in an irregular manner, on the branch of some food plant, to form a hollow shelter for the voracious creatures within.

It is not long before all the leaves enclosed by the tent have been eaten, but before this tragic event occurs the larvæ have grown considerably and are better able to

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look after themselves than when first hatched. Then they evince a desire to go out and see the world, so they scatter upon the branches of their food plant and devour its leaves greedily. At the least sign of danger, in the shape of birds or rain, they scuttle back to the shelter of their tent. We have mentioned that the fabric of the tent is tough, and so it is, but not so tough that a bird could not break it down. Why then do not the larvæ, which may easily be seen within their abode, suffer from the depredations of birds? For the same reason that most birds will not attack seeds or young plants which are protected by strands of thread, though it must be admitted that after a while thread has no terrors for the common sparrow.

On another page we mentioned a fly bearing such a close resemblance to the honey-bee that throughout the ages bee and fly have been confused. Well, the "drone-fly," as it is called, has a further interest for us. Its larva is one of the most interesting and peculiar in the insect world. The "drone-fly" delights in sunshine and honey and pollen; as it flits from flower to flower on the hottest of days one would never associate it with reeking, stagnant water. Yet it is on the surface of such water that it lays its eggs.

The larva is a most eccentric individual; he spends his time crawling along the slimy bottom of his filthy pond, yet he possesses no apparatus for breathing below water, as do all the true aquatic insects. Instead, he possesses a wonderful telescopic tail through which he breathes. The dirty-white, soft-bodied larva is about two-thirds of an inch in length, but his tail may be as long as five inches. Its tip always reaches exactly to the surface of the water. When the maggot crawls into the deeper parts of his pond his tail lengthens; when shallower water is sought his tail decreases in length. This very peculiar structure has earned the insect the name of rat-tailed maggot.

Another interesting aquatic insect is the buffalo gnat.

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The female flits along the surface of running streams and lays her eggs on rocks just below the water. Running, pure water is as necessary to this insect as was stagnant water to the "drone-fly" larva. In due course the larvæ emerge, and they spend their lives standing on their tails or crawling from place to place with a curious looping action, like a leech or a looper caterpillar.

Now, dwelling in running water and being quite unable to swim, there is always a danger of these little creatures being washed down-stream. True, they are armed with hooks on their sucker feet which enable them to obtain a firm hold of slippery rocks. In addition to these hooks, they spin fine life-lines. When alarmed they leave go of their resting-places and swing out on the end of their silken life-lines, hauling themselves back to rest when danger no longer threatens. When fully fed, they make slipper-shaped nests, not unlike those of swallows, and these they glue to a water weed with the open ends pointing up-stream.

At first the nests are closed, but later the broad ends are removed. In these nests they turn into pupæ, and when ready to emerge as flies a wonderful thing happens. The adult is a gauzy-winged creature which could not stand immersion in water, yet it emerges below water and in this manner. The pupæ take up air from their surroundings, and as a consequence a bubble of air collects between the slipper-shaped nest and the pupæ. When the fly emerges, it does so in a bubble of air. Fly and bubble rise to the surface and the insect goes on its way with wings unscathed. Could anything be more marvellous?

Los Angeles Museum
Exposition Park

CHAPTER VII

COCOONS, NESTS AND EGGS

WHAT would you think of a mother who used her child as a shuttle in weaving silk? A peculiar question to ask, no doubt; but the young of certain ants are used in this manner. One of the commonest ants of tropical Africa builds a nest of leaves fastened together by a fine white web resembling the finest silk. The leaves are fastened together at their edges and the ant community dwells within. The method of construction employed in these leafy nests long remained a mystery, for no ant has ever been known to spin silk.

An observer, quite recently, by tearing a rent in one of the nests, solved the mystery. When the nest was damaged, some of the workers defended the home, others repaired the rent, and they did so in a peculiar way, by lining up in a row and seizing the edge of the leaf, on the other side of the rent, in their jaws, the while they took firm hold of the nearer side with their feet. Then they slowly and cautiously backed, holding all the time on to the farther edge of the rent, and thus brought the two edges together. Next came other workers who cut away the old silk web along the edges of the rent, carried the pieces to an exposed situation, awaited a breeze, then let them float away in the air. After an hour's labour a strong gust of wind tore the edges of the rent out of the ants' jaws, but, undaunted, they began again, and in half-an-hour had pulled the edges near together again.

Then the most peculiar thing happened. From the inner recesses of the nest countless workers ran, each bearing a grub in its mouth. They climbed upon the portions of the leaves which were still held together by

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the workers and used their grubs as spools and shuttles. The larvæ gave off a fine silk from their mouths, and this the ants used to bind the edges of the nest together. From one side to the other they travelled, placing the grubs' mouths against the leaf till the silk had adhered to the leaf, then they passed over to the other side and repeated the process.

It must be an interesting sight to watch these ants building their nests. If the leaves are large and stiff, hundreds of ants may be required to haul a leaf down and hold it in position; it is quite a tug-of-war. Sometimes the insects holding the leaf have a chain of two or three of their comrades fastened on to them, one behind the other, each holding its neighbour by its slender waist and all at full stretch and pulling earnestly. What a strain for poor number one. When the leaf edges are far apart the ants form themselves into chains to bridge the distance and bring it down. "When contemplating the work done on these nests one cannot but marvel at the wonderful ingenuity displayed, or in endeavouring to form some idea of the vast number of grubs which must be utilised to supply the connecting web even for a moderately sized nest, for with narrow-leaved trees many scores of leaves are required to form a nest and each must be sewn."

Of all the ingenious shelters for insects' eggs, one of the most striking is the curious raft constructed by the silver water-beetle. The mother beetle may often be seen at work in the spring; she clings, upside down, to some water weed and spins a concave sheet of silk which she attaches to some plant on which she has taken up her position. Then, reversing her position, she weaves a similar silken sheet and, having done so, fixes the two together so that they form a nearly spherical cocoon, open at one end. Inside this structure she deposits her eggs in regular rows, suspended from its upper surface; next she closes the open end of the cocoon and spins a little spout

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therefrom, which projects nearly an inch above the surface of the water.

The completed structure, as it floats on the water, resembles a chemist's retort, with a narrow neck projecting into the air. In this curious little ark the larvæ remain but a short time after they are hatched, before eating their way out to the surrounding water.

Familiar as is the common cockroach, there are many people who have never seen its remarkable red-brown egg-case, which resembles nothing so much as a miniature snap-purse. Each case contains sixteen eggs, deposited in two rows, side by side, in such a manner that the ends of the eggs, from which the young cockroaches will hatch, all point towards the opening of the case. The horny, purse-like structure is kept closed at its upper edge by its natural elasticity, so that when the young roaches hatch all they need do is to push their way out of their temporary hiding-place. The mother roach displays the greatest concern in seeking a suitable shelter for her egg-case. Case and eggs are formed within her body, and she will sometimes walk about for days with the egg-case partly protruding from her body, till she finds a spot where she thinks no harm can come to her precious burden, and there she leaves it.

Many other insects protect their eggs by means of cases; certain locusts, for example, deposit their clusters of eggs in holes in the ground, and cover them with a sticky substance which sets moderately hard and forms a case around them. The gadflies deposit their eggs in curious masses, and so do the mantids. A mantis egg-case is worth a moment's consideration. In its completed form it is hard and horny, but at the time of its formation it is soft and spongy. The egg-cases vary in size according to the species of mantis, but many of them are more than an inch and a half long. They are usually yellowish-green in colour, and the eggs within are arranged in regular rows. When the eggs are being

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deposited by the mother mantis, the future egg-case is merely a mass of froth, but the action of the air causes it to harden rapidly. Curiously enough, the last eggs to be laid are the first to hatch, but all hatch within a short time of one another.

The young mantids, on hatching, push their way out of the egg-case, but do not immediately go out into the world. They first of all spin a silken thread from which they suspend themselves, after the manner of certain young spiders, till they have shed their first coats. A change of raiment seems to embolden the little creatures, for after their moult they leave their nest and start on their nefarious careers as crafty, bloodthirsty cannibals, not even disdaining their own kind, for the female mantis often devours her mate if he becomes too pressing with his attentions.

The pernicious habit of hen-pecking is not altogether unknown in the insect world. We have just mentioned the mantis, and there is a large South American water-bug which is nearly as bad, though the female does not go quite so far as to eat her spouse. Her nature is more utilitarian. She makes him carry her eggs. *Zaitha* is the name of this insect, and the female, to rid herself of maternal cares, simply deposits her eggs on her husband's back. He is by no means a willing nurse, for sometimes the couple will struggle an hour or more before the female can accomplish her design, and then her mate seems as much out of place as the top-hatted suburban father who wheels his child about the roads on a Sunday morning, the while his wife prepares the midday meal.

Miss Slater, who discovered this habit of the *Zaithas*, says: "That the male chafes under the burden is unmistakable; in fact my suspicions as to the sex of the egg-carrier were first aroused by watching one in an aquarium which was trying to free itself from its load of eggs, an exhibition of a lack of maternal interest not to be expected in a female carrying her own eggs. Generally

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the *Zaithas* are very active, darting about with great rapidity ; but an egg-bearer remains quietly clinging to a leaf, with the end of the abdomen just out of the water. If attacked, he meekly received the blows, seemingly preferring death, which in several cases was the result, to the indignity of carrying and caring for the eggs."

So diverse are the forms of insects, so varied their ways, that it is hardly surprising to learn that their eggs assume all manner of shapes and sizes. They are rarely laid singly ; sometimes groups of two or three are laid by certain insects, for instance, the solitary wasps. Usually the egg-clusters contain about one hundred eggs, and in exceptional cases—*i.e.* the social insects—each mother produces hundreds of thousands of eggs. They vary from the large seed-like eggs of the stick insects to the glass-like transparent eggs of certain butterflies. Again, they are arranged in every conceivable way by the female insect ; some are simply allowed to fall anywhere without any provision for their welfare on the part of the mother. This is the case with the stick insects. Their seed-like eggs are simply allowed to fall to the ground, and they do so with such effect in certain districts, where the stick insect is common, that they sound like raindrops falling on the undergrowth.

At the other extreme is the earwig, an Australian sawfly and a wood-boring beetle, all of which tend their eggs till they hatch and then mother their young. Midway between the utter disregard for the fate of her progeny displayed by the mother stick insect and the tender care of the earwig, there are cases innumerable where the mother insect makes every provision for her young by seeing to it that her eggs are laid in the most favourable situation for their welfare, and even displaying considerable ingenuity in preparing suitable situations for these eggs. A case in point is afforded by a little North American stem sawfly, which deposits its eggs in willow twigs, but after the laying of each egg the willow twig in

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which it is deposited is girdled, to prevent further growth which would assuredly crush the egg. The manner of depositing eggs, the situations in which they are laid, and the form in which they come into the world are all of the greatest interest.

As we shall see, eggs which are destined for an aquatic life are usually covered with a layer of jelly-like substance after the manner of frog spawn. Eggs laid on a tree may either be on its surface, as in the case of the rings of eggs deposited by the lackey moth, or actually in its tissues, as in the case of the cicada. Some eggs, those of mosquitoes, float on water; others, those of lacewings, wave on stalks in the air; some are preserved from injury by horny coverings, others are laid in great masses and protected by substances derived from the body of the mother. One thing is certain, the mother always does her best that her labours may not be in vain even if she omits to mother her young.

Some very interesting experiments have been carried out on this subject, of which we can but give the barest outline here. Taking the common cabbage-white butterfly as our example: it is well known that this insect will only lay its eggs on cabbages or on closely related plants, and with a reason—these plants and these alone form suitable food for the cabbage-white larvæ. Now all these plants possess a substance which gives them their characteristic odour, and this substance can easily be extracted. Taking some of the substance and smearing it on a piece of sacking, cabbage-white butterflies were easily persuaded to lay their eggs thereon, despite the fact that the larvæ could not possibly feed on sacking. Similar experiments were carried out with other substances and other insects with like results, showing that the sense of smell probably guides the mother insects in their choice of a site for their eggs. Be that as it may, it is wonderful that the adult insects, which sip the nectar of flowers, should know on which plants they may or may not lay their eggs.

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Certain insects' eggs cannot hatch without the aid of some higher animal, aid which is certainly involuntary, seeing that the larvæ from these eggs are parasitic. Let us consider two totally dissimilar cases. There is a British fly, not unlike a honey-bee in appearance and known as the horse bot-fly. This insect is an interesting though obnoxious pest to horses, in whose neighbourhood it may often be seen flying on warm sunny days. Suddenly the fly will dart at a horse, settle for an instant and fly away rapidly. This operation will be repeated over and over again. Each time the fly settles on the horse she deposits a single elongated egg which is so sticky at one end that it becomes attached to a single hair of its host. The eggs are always attached on some part of the horse which may easily be reached by its tongue, for a reason we shall see presently. The free end—that is, the unattached end—of each egg is furnished with a little lid. Now the presence of these eggs irritates the horse. What then is more natural than that it should lick the offending spot? And this is precisely what the mother fly intended should happen. The friction of the animal's tongue in conjunction with its saliva causes the little lids of the eggs to open, and out come the larvæ. They pass into the horse's mouth, thence to its stomach, and affix themselves to its wall. But that is another story. Let us turn to our second example, which is even more curious.

A South American fly, or rather its grub, lives in the flesh of human beings, causing ugly, suppurating tumours. How these grubs entered the flesh of their hosts long remained a mystery, till a French naturalist solved the riddle. The fly had never been seen to lay its eggs on a human being or on his clothing, yet its grubs certainly made a home in his flesh. How came they there? The capture of a blood-thirsty, blood-sucking mosquito, with some of the eggs of this obnoxious fly adhering to its abdomen, gave a clue to the mystery. Piece by piece the evidence was constructed, till at length the problem was

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solved. The fly, it appears, was in the habit of depositing its elongated eggs in clusters on the leaves of a certain plant frequented by the mosquito. Now these eggs were placed on the leaf in a most methodical manner. The ends from which the grubs were destined to hatch were placed on the leaf surface; the ends which projected into the air were covered with a sticky substance.

When the mosquito came along to disport itself on the leaf the sticky ends of the eggs adhered to its body. Before long it is certain that the mosquito will become hungry, and then it will seek some unfortunate human being to satisfy its craving. Having found its victim, it loses no time in puncturing his skin, but at the same time, probably called into action by the warmth of the human body, or stimulated by perspiration, the fly grubs beat a hasty retreat from the eggs. When the mosquito takes its departure it leaves the grubs behind. They find the puncture made by the blood-sucking mosquito and, entering, take up their residence in the flesh of their new-found host.

Many other insects' eggs depend on higher animals for their welfare. The sheep-nostril fly lays its eggs on the nostrils of sheep, and they hatch immediately they are laid, and the grubs pass up the noses of their hosts, causing them to sneeze in a vain endeavour to rid themselves of the grubs.

CHAPTER VIII

MIMICRY

MIMICRY amongst animals may be either aggressive or protective. Broadly speaking, if an animal imitates another on which it preys for the purpose of its more ready capture, the mimicry is aggressive. On the other hand, an animal which is harmless itself, but closely resembles a harmful creature, exhibits protective mimicry; for by their imitation they are frequently preserved from danger. Cases of mimicry, both aggressive and protective are common amongst insects, and from them most of our examples will be taken.

The whole realm of nature cannot furnish a better example of mimicry, or perhaps resemblance is a more fitting word in this case, than is afforded by the well-known leaf-butterfly of India and Malaya. The upper wing surface of this remarkable insect is brilliant, nay, almost gaudy. In general colour it is metallic purplish-blue, and each fore-wing is marked with a broad orange band and two clear spots. But no verbal description can do justice to its beauty. In the collector's cabinet it is a striking object; in its native haunts it must be of entrancing beauty. The wings are of curious shape, and not without purpose, as we shall see presently. Their under sides are dull reddish-brown, mottled with deep brown, a striking contrast to the upper sides.

In the resting position the wings are always folded, close together, above their bodies, so that nothing is visible except their under surfaces. The tips of the wings are pointed, the "tails" are short and blunt; the outline of the folded wings bears a remarkable resemblance to a dead leaf, with the "tails" forming the stalk. The resemblance

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is heightened by a dark streak which runs from wing-tip to tail, giving the appearance of a midrib. And this is not all. We mentioned that there are clear spots on the wings. In the resting position these spots coincide with one another on the folded wings, so that there appears to be a hole through them, just as there might be through an old, damaged leaf. Keen eyes of bird or man are necessary to detect this wonderful mimic when it is enjoying a siesta.

The leaf-butterfly is not the only insect with the outward form of a leaf. There is an African insect, closely related to the grasshopper, which bears a remarkable resemblance to a green leaf. These creatures have flattened bodies, and their wing-cases are leaf-like in appearance and colour, as also are their fore and middle legs. The hinder edges of their wing-cases, as they lie touching one another on the insects' backs, resemble the midrib of the leaf. The insects are slow-moving creatures; in fact they often remain for hours together without moving, a habit which renders their resemblance to green leaves of the plants on which they feed still more remarkable. An entomologist who studied these freaks of nature in the Seychelles relates that when food is scarce "they frequently nibbled pieces out of one another, just as they might have done out of leaves," and that they always feasted off those parts which resembled leaves.

Much better known are the stick insects, also relatives of the grasshopper. These creatures, which may be veritable insect giants, or, on the contrary, dwarfs, always bear a very striking resemblance to the stems of the plants on which they feed. They may be winged or wingless; but, in the former event, the wings are always folded tightly to the body so as to heighten their general resemblance to a stick. Their long, thin legs are frequently covered with spines, if they happen to belong to a species which feeds on a spiny tree, or with mossy-looking growths, if they frequent moss-covered trees.

Professor Drummond naively described a stick insect

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as follows :—“ Take two inches of dried yellow grass stalk, such as one might pluck to run through the stem of a pipe ; then take six other pieces nearly as long and a quarter as thick ; bend each in the middle at any angle you like, stick them in three opposite pairs, and again at any angle you like, upon the first grass stalk and you have my ‘Chirombo’ [native name for the stick insect]. When you catch him, his limbs are twisted at every angle, as if the whole were made of one long stalk of delicate grass, hinged in a dozen places, and then gently crushed into a dishevelled heap. Having once assumed a position, by a wonderful instinct he never moves or varies one of his many angles by half a degree. The way the insect keeps up the delusion is indeed almost as wonderful as the mimicry itself, and you may turn him about and over and over, but he is mere dried grass, and nothing will induce him to acknowledge the animal kingdom by the faintest suspicion of spontaneous movement.”

The stick insects have their counterpart in this country. Everyone knows some, at least, of the large family of “looper” caterpillars, the insects which derive their name from their curious looping gait, rendered necessary by the fact that they have legs at either end of their bodies and none in the middle. There are many species, but all have the same habit, which renders them difficult to detect when at rest. Feeding, for the most part, by night, when they are safe from the attacks of birds, they rest motionless by day. Taking a firm hold on some twig of their food plant with their hind legs, they attach a fine thread of silk to their support and posture themselves in an erect position, thus bearing a striking resemblance to a broken twig of the plant on which they are resting.

Brown caterpillars select brown twigs, green ones favour green twigs, and, in either event, are very difficult to detect. The silken thread acts as a stay-rope and takes a considerable amount of the strain which the insect would otherwise feel in its immobile periods.

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Equally remarkable are the caterpillars of the pine beauty moth, which need no artifice to render themselves inconspicuous other than their wonderful protective colouring. Their favoured food consists of the dark green, needle-like leaves of the pine-tree, which are often striped longitudinally with yellowish-white lines. The caterpillars are dark green in colour, of such a shade as to exactly match the pine leaves, and on either side of the middle line of their backs they bear a white stripe. Away from their food plant they are very conspicuous creatures. Even from our description they probably do not appear much like pine-needles in colour, but the fact remains that on their food plant they are wellnigh indistinguishable.

It is curious to note that lichen-covered trees are very frequently used as resting-places for insects that desire to escape detection on account of their peculiar colour schemes, or shall we say that many such insects are so marked as to escape detection when resting on lichen-covered trees? Instinct, habit, call it what you will, appears to point out the most desirable resting-places for each insect. The common red underwing moth, whose fore-wings are mottled grey, must never be sought on green leaves during its daylight resting hours, but on some old weather-beaten fence, of such a nature that the colours of insect and support harmonise in marvellous manner. Still more remarkable is a little Madagascan beetle which not only resembles the lichen-covered trees on which it lives in colour, but to some degree in form, for its wing-cases are knobbed all over with little warty outgrowths, which still further heighten the illusion.

Wonderful indeed are the devices employed by Nature in moulding her children ; among the most extraordinary are those insects which resemble bird droppings. There are several small moths which, with white, black-tipped wings, so closely resemble the excrement of birds that detection by insect-eating enemies is almost impossible.

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A Javan species of spider, too, has assumed this strange garb, not as a means of escaping observation, but in order the more readily to obtain food. Unlike the majority of spiders, he spins no web, but rests in some exposed place, a conspicuous black and white, inert-looking mass. Strange as it may seem, some butterflies are given to making a meal of such unpleasant fare and, mistaking this spider for a meal, they settle upon him, with disastrous results, for they are immediately seized and thus provide a meal.

Let us now turn to some of the harmless insects which resemble harmful ones, or at any rate insects well provided with defensive organs. The common conception of a moth is an insect whose wings are covered with scales of such a nature as to give them a distinctive colour. Occasionally there is a circular patch or eye which is devoid of scales and thus forms a transparent spot. In certain families there are moths whose wings are almost totally devoid of scales, to such an extent, at any rate, that they are popularly known as "clearwings."

One species, the hornet clearwing moth, has its body banded with buff and orange-yellow, remarkably similar to those of the hornet, which, in fact, it mimics. The rapid, nervous flight of these insects heightens the illusion, and when they are on the wing it requires an expert to distinguish the peace-loving moth from the oft-times aggressive, formidable hornet. Moths, however, are not without rivals in their mimicry.

A common British beetle bears such a remarkable resemblance to the wasp that it has earned the title of wasp-beetle. It is well known that what may be termed the delicate flying wings of the majority of beetles are totally protected, when not in use, by hard wing-cases. In the wasp-beetle, however, the wing-cases, which, by the way, are marked with black and yellow, after the manner of a wasp, are so reduced in size that the membrane-like flying wings are fully exposed. This fact renders the

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insect more like a wasp than it would be were its wing-cases of normal dimensions. The likeness does not end here, though more careful observation is necessary to detect the next point of resemblance. The wasp has four wings, and its hind and fore wings are fastened together by a series of minute hooks, invisible to the naked eye. Beetles have only two wings, but the wasp-beetle has each wing lobed at its hinder margin; thus its two wings appear extraordinarily like the four wings of the wasp.

Examples of mimetic insects could be quoted at length; some of them have been known, or, more correctly speaking, have been confused with other insects, since Biblical times. The myth that animal carcasses generate bees was mentioned in the story of Samson, in the book of Judges; it has held sway in nearly every country the world over, and is perpetuated as the trade mark of a well-known brand of golden syrup, in the form of a drawing of a lion from whose anatomy a number of bees are issuing. Now bees do not feed upon animal matter. How can the myth be explained and how has it arisen? The fact of the matter is that there is a certain fly, belonging to the family of hover-flies, those perfect aeronauts that may be seen hovering, with wings vibrating so rapidly that the human eye is quite incapable of following their movements, the while they are on the look-out for their prey, the succulent green-fly.

These hover-flies so closely resemble the honey-bee that they have been named "drone-flies." The drone-fly breeds in carcasses or in stagnant water, so that the almost universal and absolutely time-worn myth does not require much explanation after all. Another family of flies mimics bumble-bees. The robber or buccaneer flies, as a family, are strikingly mimetic. These flies are veritable hawks of the insect world, pursuing and capturing their prey on the wing, but retiring to a nearby resting place to devour their victims. Those of one species

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closely resemble wasps ; those of another are remarkably like bumble-bees, even to the extent of having thickened hind legs, like the pollen-bearing members of the bumble-bee family. As this modification is perfectly useless to the fly, it simply amounts to a device destined to add to the fly's resemblance to a bee.

In another chapter we referred to the leaf-cutting ants. Those destructive creatures march in droves to some favoured shrub, and each one nibbles a piece of leaf therefrom before returning home. On the homeward march the booty, in the shape of a snippet of green leaf, is carried on high over the insect's head and, an ant legion, each member of which bears a green leaf, presents a curious spectacle and affords an opportunity for a very striking example of mimicry.

So far all our mimetic insects have resembled a plant, an insect or some non-living material ; but a bug which lives in the same part of the world as the leaf-cutting ants goes one better—he mimics the ant plus his leafy burden. This bug is a curious-looking creature, for on his back he bears a thin, flattened outgrowth, green in colour, which at a little distance bears a very striking resemblance to a piece of green leaf, and he himself is not unlike an ant. We may well inquire the reason for this so-called aggressive mimicry. If it be of a purpose, as some aver, it is surely intended to help the imitator to more readily obtain its prey ; for the fly which resembles the bumble-bee preys upon those insects or, in other cases, it assists the mimic to avoid its enemies ; the moth which mimics the hornet is not nearly so likely to meet with a tragic end as a moth which does not possess this advantage, for the sting of the hornet is notorious, even among the lower animals.

Amongst insects, there are other forms of protection from their enemies which can hardly be termed mimicry or even protective resemblance ; perhaps protective colouring would be a better term. These insects are all remarkable

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for their brilliant hues ; so vivid, in fact, are they that it might be thought that undue attention would be drawn to the creatures so endowed. And this is the case. To be conspicuous, in some circumstances, is an advantage. Most of these brightly coloured insects are extremely distasteful to birds and other insect-eating animals. Some of them, the blister-beetles, give off an acrid fluid when they are touched and accordingly have no enemies seeking to make a meal of them.

A few young birds, who have not yet learned the ways of the world, may perchance make an attempt on the lives of some of these smartly liveried insects, but even birds learn by experience, and the insect with the garish coat is usually protected by his very gaudiness.

Again, certain insects are protected by their having hairy coats. Few birds, except the cuckoo, will make a meal of a hairy insect, however tempting he may be in other respects. In some cases the hairs of insects are irritable little poisoned stilettos, causing intense irritation whenever they penetrate the skin, which they may easily do, by reason of their small size.

Mimicry amongst birds is by no means uncommon.

“Protective mimicry is well illustrated by the common cuckoo. This bird presents a really striking resemblance to the sparrow-hawk, and thereby, it is supposed, it is enabled to carry on with ease its nefarious practice of putting its young out to nurse. By any small birds, such as are victimised by the cuckoo, the sparrow-hawk is greatly dreaded. So disguised then, the male cuckoo, when its paramour is ready to dispose of an egg, hovers over spots likely to contain nests of the desired foster parents. These threatened, as they suppose, by the bully of the country-side, at once commence to buffet him, gaining courage, in the defence of home, which at other seasons of the year they cannot command. Under this attack the pretended marauder beats an affected retreat, followed by his puny adversaries. When the pursuit has carried

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away the pursuers sufficiently far, the female quietly slips up to the nest and then drops in her egg. On the return of the frightened birds, they either fail to notice the addition to the nest, or are indifferent, finding the eggs they left still whole."

In Australia there is a remarkable case of bird mimicry. The powerful friar-birds, which go about in flocks, and are therefore less likely to meet with mishap than if they lived alone or in pairs, are mimicked by the harmless, solitary orioles, and this is good for the orioles. Hawks hesitate to attack the orioles, for perchance they might be friar-birds, and the result of such an attack would be unpleasant for the hawk. There are many other examples of weak birds copying strong ones. The fork-tailed cuckoo of India mimics the powerful king-crow; another Eastern cuckoo, the brain-fever bird, closely resembles the Indian sparrow-hawk; a bulbul copies a shrike, and in each case the weaker bird benefits by the resemblance, if only to the extent of misleading possible enemies.

On the other hand, very many birds of prey mimic harmless birds, thereby gaining an easier livelihood than if they appeared in their true colours. Just as the cuckoos commonly mimic more powerful birds, so do many of the hawks mimic harmless ones. An Indian hawk, for example, closely resembles so typical a sea-bird as the tern. The great skuas, again, though sea-birds, are also birds of prey, and curiously enough some of them mimic eagles. Why should one bird of prey mimic another bird of similar habits? But we are digressing into questions too abstruse for a book of this nature; in fact the whole question of mimicry in birds is beset with difficulties.

CHAPTER IX

GROUND AND UNDERGROUND NESTS

THERE is little in the whole realm of nature which evokes our admiration more than the craftsmanship of certain birds. Some, 'tis true, making no nests, lay their eggs upon the ground or on some bare rock ; others scrape a hollow in the ground, a mere excuse for a nest. Some nests, again, are rough and untidy in the extreme, but they only serve to emphasise the good workmanship of the neater, more ingenious structures. The village boy who carelessly destroys the hedgerow nest rarely pauses to consider that, at one stroke, he is utterly and often literally casting to the winds the result of much effort and no little skill.

Of the simple, shall we say primitive, nests we have a large selection from which to choose. Birds like the penguin and the guillemot may safely be dubbed the least skilful of artificers ; in fact they build no nests at all, but simply lay their eggs on the bare rock. Exactly how and why the guillemot's eggs remain in their precarious positions on the side of some beetling cliff we shall relate in our chapter on birds' eggs. The case of the penguin is extraordinary. Not only does this bird omit to build a nest, but he, or she, uses his or her feet as supports for the single egg. When about to sit, the egg is rolled up on to the upper sides of the feet and the sitting bird squats upon its charge. The hen does most of the sitting, but the cock bird takes his turn.

When the change is made from one bird to the other, it is carried out with as much ceremonial as the change of guard outside a royal palace. The cock bows to the hen when about to relieve her, she returns the compliment ; he then carefully scrutinises his charge and finally takes

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it over. Seven weeks is the time required to hatch these eggs. "One bird could not sit on the same egg for seven weeks. Incubation is carried out not by one pair but by twelve or more, which stand about waiting for a chance to seize either a chicken or an egg, as the post of incubator becomes vacant. Every adult male and female has the desire to sit on something, therefore there is one egg or one chicken to ten or twelve adults. Probably this allows each bird to obtain sufficient food through so long a period of incubation.

"Not only do barren females take their turn, but males also help. Every bird has the same bare patch of skin in the middle line of the lower part of the abdomen, against which the egg is closely held for warmth. Again and again the birds, weighing anything up to 90 lb., make wild dashes to take charge of any chicken that happens to find itself deserted. The first bird to seize the chicken is hustled and worried on all sides by the others while it rapidly tries to push the infant in between its legs with the help of its pointed beak, shrugging up the loose skin of the abdomen the while to cover it. No great care is taken to save the chick from injury. The chickens are fully alive to the inconvenience of being fought for by so many clumsy nurses, and they make the best use they can of their legs to avoid these attentions, preferring to freeze and starve rather than to be nursed. Half of these unfortunates are killed by kindness." So wrote Dr E. A. Wilson in his *Voyage of the Discovery in the Antarctic*.

The nightjar is another bird which disdains a nest. It may make use of some natural depression in the ground, but as for scratching one for itself, the nightjar would never do such a thing. The bare ground at the foot of a fir-tree or under some furze bush is the favoured haunt of this bird.

The noddy, a species of tern, is a fool of a bird, yet it goes a step further in the nest-building scale. Like the

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guillemot, the noddy favours some rocky ledge, but it places seaweed thereon, though it must be confessed that it displays no skill whatever in the doing of it. Year after year this bird returns to the same nesting-place and each season adds more seaweed to its nest; in consequence, after a few seasons it may have accumulated vegetable matter to the thickness of a couple of feet.

Rather more ingenuity is displayed by the ostrich and its kind. The nest in this case is merely a hollow scratched in the sand and as such slightly more advanced architecturally than the nests we have already mentioned. When, however, the ostrich leaves its rude nest for any reason, it takes the precaution of covering its eggs with sand, to conceal them from marauding animals on the look-out for an inviting meal.

There is one very curious habit of these birds that is worth mentioning—namely, the habit of scattering a few odd eggs about the nest. What exactly is the object of this peculiar trait is not very obvious. Some naturalists assert that these eggs are intended as food for the young birds when they first hatch. Be that as it may, the habit is common not only with the ostriches, but amongst the closely related emus, cassowaries and rheas. Another step up the scale of skilful nest-building brings us to the nests of certain game birds, such as grouse and partridges. These, again, are but hollows in the ground. However, they are lined with vegetation, and a certain amount of skill is displayed in their construction.

Let us not run away with the idea that the ground-nesting birds are all tyros in the art of building. Many remarkable nests are built on the ground. That great winged sea-bird, the albatross, whose home is on the ocean, to whom a visit to land is a means to an end—the upbringing of its young—builds a remarkable mud-encircled nest. Usually, birds, being far-seeing and intelligent creatures, build their nests first and lay their eggs afterwards. The albatross, reversing this procedure, lays its single egg on

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some bare rock and afterwards surrounds it with a rampart of mud and seaweed. Nesting on the islands of the Southern Seas and displaying an absolute fearlessness of man during the nesting season, this wonderful bird is in a fair way to suffering extinction, for, needless to add, it is slaughtered indiscriminately.

The noddy is not the only bird that adds to its nest year by year, without taking the trouble to remove the debris of the previous season. The flamingo also has this curious and slovenly habit. The newer nests of these birds are only a few inches in height, the older ones a foot or more. The flamingo usually builds on marshy ground and the birds breed not in pairs but in great flocks. The nest is constructed almost wholly of mud, which is scraped together by the birds' beaks and patted into shape with their feet. The newer nests resemble soup-plates, being circular in outline, with a hollow in the centre for the reception of the eggs; the older nests are conical mounds of mud, scooped out at the top. A few feathers as a lining complete the structure.

For years an erroneous account of the sitting birds held sway. It was stated that the hens straddled their nests when sitting, and many illustrations of flamingos incubating their nests in this manner have appeared in natural history books. More recent and more reliable observations have shown that the flamingo sits on its eggs in the ordinary way, with its legs bent beneath it. It is sad that these pretty stories should be refuted; still, there are plenty of well-authenticated facts in nature which are more remarkable than the inventions of some imaginative man.

The mound-birds and brush-turkeys are members of a family with peculiar nesting habits. They lay their eggs either in sand or in large mounds composed of decaying vegetable matter and consign the duties of incubation to the rays of the sun or to the heat given off by the putrifying herbage. The edifices constructed by these birds are remarkable for their size, though the birds

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themselves are by no means large. Cartloads of material are used in building, and the mounds may measure more than one hundred feet in circumference.

Wallace, in *The Malay Archipelago*, thus describes the habits of these birds: "Of this rubbish the mound-birds form immense mounds, often six or eight feet high and twenty or thirty feet in diameter, which they are enabled to do with comparative ease by means of their large feet, with which they can grasp and throw backwards a quantity of material. In the centre of this mound, at a depth of two or three feet, the eggs are deposited, and are hatched by the gentle heat produced by the fermentation of the vegetable matter of the mound. When I first saw these mounds, in the island of Lombok, I could hardly believe that they were made by such small birds, but I afterwards met with them frequently, and have once or twice come upon the birds engaged in making them. They run a few steps backwards, grasping a quantity of loose material in one foot, and throw it a long way behind them. When once properly buried, the eggs seem to be no more cared for, the young birds working their way up through the heap of rubbish and running off into the forest." This habit of leaving the chicks to their own devices is foreign to most birds, in which, as a class, the maternal instinct is very highly developed.

The Australian brush-turkey builds a somewhat similar nest. Like the mound-birds, the brush-turkeys make use of their feet for building operations. Their first care is to trace a circle of large radius, and round this they walk, picking up leaves, twigs and grass as they go, and throwing them to the centre of the circle they are describing. Narrowing their circle by degrees, they finally build up a good-sized conical mound. Having constructed a framework, so to speak, they proceed to hollow out the centre, and this they do to a depth of a couple of feet or more. In this hollow the eggs are deposited in a circle, with their pointed ends downwards. The eggs are then

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covered with vegetation, whose decay, aided by the sun's rays, completes the process of incubation.

Although the brush-turkey eschews sitting upon its eggs, the male bird is loath to leave them to Fortune. He displays considerable solicitude for his future chicks. By some wonderful instinct, he knows just when the temperature within the nest is becoming too high or too low. In the former case, he scrapes off the covering from above the eggs and so allows them to cool ; when the temperature falls he adds a covering of leaves. Many times a day he tends his eggs in this manner. Another Australian mound-builder is well provided for by nature. Termites, to their undoing, crowd round the eggs within the mound, without, however, doing them any harm. Why they should do so has not been satisfactorily explained, but their presence is welcomed by the chicks when they hatch, for they serve as the first food of the hungry youngsters.

The coot, the moorhen and the dabchick all build nests which, to all intents, float upon water, though the moorhen occasionally selects some spot near to, but not upon, the water. Take a stroll along the bank of any tree-bordered stream and notice that where the branches of the overhanging trees touch the water there are, here and there, clumps of vegetation, brought down by the stream and caught in the branches. Most of these masses are merely drift-weed ; some may be the nest of a moorhen. A rudely built structure of grass and other water-side plants, the nest of this bird is frequently anchored to some tree branch, where it dips into the water. Six to eight eggs are laid at a time, yet one may pass nests again and again without seeing a sign of them, for the careful birds always cover them with loose herbage when they leave their nests, unless they are disturbed and compelled to leave in a hurry.

This habit of covering the eggs is common among water-side birds. By some the object is thought to be to retain the warmth during the absence of the mother, but

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the more probable explanation is the protection of the eggs. The moorhen chicks, beautiful little balls of black down, take to the water immediately they are hatched, for they are able to swim as well as their mother, whom they always accompany during their early days.

A very pretty sight is often afforded by young dabchicks and their mother. The dabchick is a little bird, her chicks are minute; there is no other word to describe them. They swim merrily by the side of or near their mother when no danger threatens, but, should they be alarmed, they scuttle to her side with all haste and nestle 'neath her outstretched wings. Then she, for greater safety closing her wings, dives below the surface of the water, taking her family with her.

To anyone who has not studied bird life it must seem strange that birds, essentially creatures of the air, should nest below ground. Curious as it may seem, the fact remains that a goodly number of species are burrowers or borrowers, for some construct their underground homes, others appropriate the burrows of other animals.

The early stages of the burrowing habit may be seen in the nests of the black-backed courser, a Nile-frequenting bird, which buries its eggs in the sand on the banks of that river and leaves them to be hatched by the sun's rays. When eggs are hatched in an incubator it is necessary to sprinkle them with water from time to time; the courser also keeps its eggs moist by wetting its breast in the river and then squatting on the sand over the spot where its eggs are buried.

A slight advance on this crude nest is shown by one of the mound-builders, a bird which belies its name, for, instead of building a mound, it burrows obliquely into the sand, for three feet or more, and there deposits its eggs. Having done so, it comes to the surface, covers the entrance to the burrow, and leaves the rest to chance and the sun.

The kiwi, a New Zealand bird, and one of Nature's

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riddles, is a burrower. This creature, with its hair-like feathers, its nostrils at the end of its long, curved beak, instead of at the base as with other birds, and its apparently wingless, tailless body, though not uncommon, is rarely seen, for it is shy and a night bird. By day it hides in its burrow, a short tunnel ending in a chamber lined with fern leaves. In this chamber the hen deposits her egg, which is remarkable for its size, being one quarter the weight of the bird that laid it. No bird living lays a larger egg for its size. The kiwi is probably possessed of a keen sense of smell, for it has a habit of probing moist ground with its long bill and sniffing out luscious worms on which to make a meal.

There are many burrowing birds in Britain. The sand-martin is one of the best known and is, moreover, one of the most expert burrowers the world over. In the selection of a site for its nest the bird displays excellent judgment. Soil that is easily worked is preferred to that of a harder nature ; but there is one essential, the ground in which the tunnels are made must be of a nature that there is no fear of the walls of the excavation falling in. Should suitable soft soil not be available, this little bird, with the fragile beak, will not eschew sandstone.

A convenient sandy cliff is the site usually chosen, and, clinging thereto, the martin sounds the surface, by tapping with its beak, till it finds the ideal spot for its purpose. The little bird is a clever engineer. Clinging to the face of the cliff with its feet, it works in a circle, chipping pieces of soil or rock away with its beak. The actual burrow is inclined slightly upwards, and in working thus the bird displays its wisdom, for thereby rain is prevented from reaching the nest within. For a couple of feet or more the work of excavation is continued ; soil is broken by the bird's beak and thrown out of the tunnel by its feet. Unless the luckless little engineer should encounter a rock or tree root during its labours, the work is rapidly completed. Should an obstruction be encountered, either

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the work is abandoned, or the bird deviates from its usual straight course in order to avoid the obstacle. The burrow completed, a chamber is made at the terminus, and in the chamber a nest of dried grass and feathers is built.

As the sand-martins always live in colonies, a favoured cliff is very soon riddled by their nest-holes. They seem to live happy, care-free lives, for, by the nature of their nesting habits, they are well protected from all enemies, except the marauding schoolboy.

An occasional visitor to our shores, with nesting habits similar to those of the sand-martin and gorgeous plumage which compares favourably with that of any tropical bird, is the bee-eater. About the size of a thrush and not so heavily built, the bee-eater is a veritable living rainbow, Green, blue, yellow, orange, brown, white and metallic black are the colours which, harmoniously arranged and displayed to advantage during the bird's elegant flight, render it "almost too beautiful to belong to this world." The colours of its exquisite plumage vary as the light strikes them at different angles. So gorgeously arrayed is the bee-eater that it is hardly necessary to add that it is in great request as a trimming for ladies' hats.

Like the sand-martin, this bird lives in colonies, and its burrows are always excavated in the side of a cliff. Fragile as is its beak, it is yet strong enough to tunnel into soft soil. As an engineer it compares unfavourably with the sand-martin. Its burrow rarely exceeds a foot in length, so that the sitting bird is plainly visible from the outside. Moss is the material of which the nest is composed, if the structure deserves the name of nest, for it is little more than a clump of moss on which the pearly white eggs are laid.

Our most richly apparelled native bird is undoubtedly the kingfisher. Though quite common in all parts of the country, he is not so frequently seen as might be expected. Despite his gorgeous coat, he harmonises so well with his surroundings that, when at rest, only the experienced eye

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can detect his presence. As he flies down-stream, a streak of exquisite azure, he is remarkably conspicuous. It is sad to relate that this beautiful bird and its nest are possessed of an odour which is wellnigh overpowering, as we shall relate in a moment.

Selecting some spot on the bank of a stream where fish are plentiful, the kingfisher excavates a hole in leisurely manner: a month is often expended in this engineering feat. The entrance to the tunnel is always kept small, so small, indeed, that one marvels how the bird can enter. The tunnel itself is often of a tortuous nature, to avoid tree roots and other obstacles, but it always inclines gently upwards, so that a rise of a few inches in the level of the stream will not flood the nest. At the end of the tunnel, usually about two feet from the entrance, a low, broad chamber is made, and here the nest is constructed. And curious indeed is this nest, being constructed of dry fish bones, those of minnows for the most part.

Certain birds, whose food consists of boned animals, are in the habit of disgorging the bones of their prey after they have digested the softer parts. The kingfisher is one of these birds, and it is from the bones of these ejected food pellets that the nest is built.

As may be supposed, the nest is of the most fragile description, and it was years after the nesting habits of this bird were fully understood before a complete nest was brought to light. Sometimes the remains of dragon-flies' wings may be found amongst the bones comprising the nest, a sign that the eggs have been hatched, for it is upon these insects that the young kingfishers are fed. Little wonder that the haunt of the kingfisher may be easily detected by its smell. The decaying flesh on the fish bones and the excrement of the fish-eating birds combine to produce an odour which is beyond human endurance. The nest, the tunnel, the bird itself, reek of putrid fish.

Many birds nest in burrows but are not true burrowers, for the reason that they take advantage of some other

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animal's industry and appropriate its home. Midway between the burrow-makers and the burrow-stealers there are a few birds which will do their own excavation if they are unable to make use of a ready-made home.

Of these birds on the border-line, the puffin is perhaps the best known. This almost parrot-like sea-bird, with its powerful, many-hued beak, is an ardent tunneller when once it makes a start. The male undertakes most of the work, and so intent does he become upon his labours that it is possible to capture him without difficulty while he is plying his beak to good effect in the soft soil. For some reason the puffin's burrow is curved; moreover, it is extensive, usually being three feet or more in length, and it is provided with a second exit, in case the arrival of some enemy should make a hasty retreat imperative. Industrious as a burrower, the puffin is no nest-builder, for the single white egg is simply deposited on the soil at the termination of the burrow.

We must not dwell too long with these ground-burrowers; there are so many that space precludes the mention of them all. The stormy petrel nests in burrows; the sheldrake and stockdove do so too; even the jackdaw, failing a better nesting site, will take possession of a deserted rabbit-hole.

Let us give a little attention now to those birds which nest in holes but not in the ground, the tunnellers as distinguished from the burrowers of the bird world. In Britain we have excellent examples of such birds in the shape of the woodpeckers. Of wood-working birds, the world over, there are none to compare in neatness of craftsmanship with the woodpeckers. The entrances to their nests are always so truly and well constructed that they might have been made by a carpenter with a large brace and bit.

The woodpeckers are admirably built for the work they undertake. Their beaks are straight and strong; their feet, with two toes pointing forwards and two backwards,

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enable them to cling tenaciously to the bark of any tree, and the stiff quills of the tail feathers, when pressed against the tree, lend the bird additional support. When on nest-building bent, the first care of the woodpecker is to find wood in suitable condition to be bored. Tapping the tree here and there with their beaks, their search is rewarded ere long by the discovery of what they look for.

Preferably a spot is chosen where some fungus has done its deadly work of killing the tissues of the tree or, maybe, the end of a broken branch where the wood is already well rotted by the rain. In any event, it is the object of the birds to find a patch of decayed or partially decayed wood. Having done so, the actual engineering work begins. Taking firm hold of the bark with its feet, supporting itself by its stiff tail feathers, the bird plies its sharp beak in pickaxe fashion against the already softened wood. In an incredibly short time a perfectly circular hole is made, also a horizontal tunnel of a few inches in length. At the end of this short tunnel the bird works directly downwards and hollows out a flask-shaped cavity in the tree. At the bottom of the cavity there is a collection of wood chips and shavings, and on these the snow-white eggs are laid. Powerful a bird as the woodpecker is, often and often it completes its labours only to find that its place is usurped by the diminutive wren, who simply turns out the rightful owner and takes possession of the nest.

Far more interesting are the hornbills, though, as craftsmen, they cannot approach the woodpeckers. They are natives of the tropics of the Old World. They are called hornbills because of their enormously developed beaks, which are of various weird shapes, according to the species. So dreadfully out of proportion do those beaks appear in some species that it seems that their owners must be sadly hampered by so heavy a load; but, as a fact, though of so unwieldy proportions, and enormously strong, their beaks are fairly light.

The hornbills have curious and wonderful nesting habits.

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The duties of incubation are carried out by the hen bird, who places herself in voluntary confinement, whilst the male feeds her and her chick during the whole period. Possession is taken of a roomy hole in a tree, high from the ground ; in this cavity the single egg is laid. As soon as the hen commences sitting, her mate assiduously walls her in, leaving only a very small hole through which he may pass food.

Exactly the nature of the building material used by the hornbills seems open to doubt. Some say clay is used ; others a secretion of the saliva mixed with fragments of fruit ; others, again, have found the skeletons of centipedes in large numbers in the material. The broad, flat beaks of the birds are used after the manner of a mason's trowel, and it is said that the hen lends a hand, or rather a beak, in walling herself up. The heat of the tropical sun soon dries the material used in the masonry and it sets almost as hard as granite, so that escape for the hen is impossible.

From this time onwards the male hornbill acts as a dutiful husband should. He is unremitting in his attentions on his wife, searching the district far and wide for the daintiest morsels on which to feed her. Without his aid she would certainly starve. But though the male is in possession of his freedom, he is the one to starve as a rule, for he is so solicitous of his mate that he appears to forget that food is necessary for himself. The food is passed to the hen in the form of a bolus enclosed in a coat derived from his own gizzard, so it is said. Other observers state that the hen's fare is divided into courses consisting of fruit and other vegetable food, insects, mice and reptiles.

By the time incubation is complete the enforced captivity and lack of exercise, combined with excellent and abundant fare, makes the hen decidedly fat. The poor male bird, on the other hand, is often reduced to a mere skeleton ; in fact he frequently dies of starvation. The precise meaning of the incarceration of the hen is open to some doubt, but

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probably it is merely as a protection against marauding monkeys and reptiles.

Another theory is that it affords protection to the hen during her moult, for she moults while sitting ; but, as a well-known naturalist says, this explanation seems "neither logical nor plausible." There are certain tunnellers which, like the burrowers, take possession of ready-made holes. The starling, robin, wryneck and certain titmice are cases in point.

CHAPTER X

NESTS IN TREES

THERE is far greater variety amongst the nests built in trees than amongst those built on or under the ground. There are great differences of position, in material and, most important from our point of view, in craftsmanship. In size, too, nests vary remarkably, from the nest of the tiny humming-bird, no larger than a thimble, to the six-foot-diameter nest of the hammer-head. In point of size the nests of the humming-birds are the smallest of all by far. Usually they are composed of vegetable down and the finest of fibres, and they are ornamented on the outside with lichen, to render them as inconspicuous as possible.

The situation in which these nests are placed are as varied as their shapes. A favourite position is the extreme tip of some leaf. Whatever the situation, however, one substance appears to be used by all humming-birds to attach their nests to their supports, and the substance is the web of a spider. Spiders' sheet webs are mingled with moss and other vegetation to form a compact, close-knit felt for the body of the nest, and spiders' orb webs are used to bind the nests to leaves, branches, the faces of rocks, etc., as the case may be.

One species of these little birds evidently takes a delight in its architectural work ; perhaps they all do so, but they are not given to building more than they can help, as a rule. Well, the humming-bird we were about to mention lays eggs about the size of an ordinary boot-button, yet it builds a nest nearly the size of a football, with a tiny cavity at the top for the eggs. These large though frail nests, suspended from the stem of some climbing plant, are sometimes found to be ill balanced

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when they are completed. Such a state of affairs would be fatal to the safety of the eggs, but the little architect is fully equal to the occasion. No, it does not build its nest anew, but daubs mud or even weaves small pebbles into the nest fabric in sufficient quantity to restore equilibrium.

The nest of one of our British birds, the chaffinch, is strongly reminiscent of the architecture of the humming-birds. A clumsy structure maybe compared to a humming-bird's nest is that of the chaffinch, yet for deftness of working and in neatness there is no bird anywhere to beat the "storm-bird," as the chaffinch is called in some parts of the country. The bird always selects a spot which offers a firm foundation for its nest, such as the point where several branches issue close together from a tree trunk. Wool is the chief component of the structure, but the wool is so deftly woven with moss, thistle-down, and spiders' webs that the whole forms a felt of remarkable firmness and elasticity. In fact the chaffinch's nest may often be pressed almost perfectly flat, yet it will regain its normal shape when the pressure is removed.

The outside of the nest is always decked with some substance which harmonises with its surroundings and renders it very inconspicuous; so well, in fact, does the little bird accomplish its object that its nest is never easy to find. The variability of external building material is the most remarkable fact about the chaffinch's nest. "A nest built in a dead gorse bush had the outside garnished with little pieces of decayed wood to imitate the brown foliage and withered blooms of the bush; a nest on the lichen-covered branch of a birch-tree was studded so thickly with bits of lichens, attached by spiders' webs, as to resemble a knotted prominence of the birch itself; lastly, a nest composed externally of the greenest of mosses, bespangled with small bits of white paper, was built in a whitethorn in full flower, and it resembled most closely an exceptionally handsome bunch of bloom."

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The lining of the nest is in itself a work of art : hair—cow's hair for choice—is arranged round the bowl of the nest with almost mathematical precision. Perhaps one or two birds can rival the chaffinch as architects—its near relative, the goldfinch, runs it close—but none can surpass it. The nest of the goldfinch is not unlike that of the chaffinch, but it is usually placed near the end of a branch and, in this position, is subjected to considerable shocks during a wind. The goldfinch provides for such a contingency by curling the edges of its nest inwards, so that the eggs are in no danger of falling out.

The long-tailed tit runs the chaffinch very close as a nest-builder. Both birds use practically the same materials and both are equally adept in the arts of concealment. But whereas the chaffinch builds a cup-shaped nest, that of the long-tailed tit is domed ; in fact, in size and shape it resembles nothing so much as a large-sized cricket ball, with a hole at one side for entrance and exit. Often the nest is more oval than round, and sometimes even it is flask-shaped. Again, nests have been found with two holes, and one is recorded with a little flap over the entrance to act as a door, which the birds must needs open and shut each time they visit the nest. The interior of this ingenious structure is always luxuriously upholstered with downy feathers in such quantity that the eggs literally lie in rather than on them.

The golden oriole, which is unfortunate in being persecuted for its brilliant plumage and for its tasty flesh, which is considered a delicacy, has somewhat peculiar, though by no means unique, nesting habits. The first-made nest of this bird is a shallow structure of grasses interwoven with wool, and is usually placed near the end of a branch. Should good weather favour the birds during the nesting season, the nest will be left in its original shallow state ; but in stormy weather the eggs, having no inverted nest edge to save them as in the goldfinch's building, must be protected from risk of falling

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out. The wise oriole simply deepens its nest, with the result that the eggs are placed once more in safety. One of the golden oriole's discarded nests at the end of the season affords a sure indication of the state of the weather during the previous weeks.

We have lauded the work of the chaffinch as a model of delicate craftsmanship. At the other extreme we may safely place the work of the branch-building pigeons, the ring-dove and the turtle-dove, for their efforts hardly deserve the name of nest. The ring-dove usually selects a fir-tree for her nest. On a suitable spray of leaves she places a few long twigs in irregular fashion, followed by a few shorter twigs laid anyhow, the whole forming a mere flimsy, flat platform. The eggs deposited on this platform may easily be seen from the ground below. One might wonder how in the world the young ones are prevented from falling to earth, and it happens in this manner. With most birds the chief care, or one of them, is to keep their nests clean. With the ring-dove the case is different, and the droppings of the young quickly form a cement which binds the twigs together into a solid mass through which there is no fear of anything falling.

The magpie builds a domed nest, though one quite distinct from the natty little abode of the long-tailed tit; it is as large as the tit's is small, as rough as the other is dainty. Despite its unkempt appearance, it serves its purpose admirably, and is by no means easy to detect, being always placed in the upper branches of some high tree, where it bears a striking resemblance to the natural outgrowth of the tree. A strong foundation is the first care of the magpie architect. This is always composed of sticks cemented together with mud; not only so, but a thick layer of mud is placed atop of this. Above this substantial groundwork a number of sticks, usually those with formidable thorns, are arranged to form a dome. The nest is completed by a lining of root fibres on the floor to receive the eggs. Exactly why the magpie

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should be so partial to thorns for the construction of its nest is hard to say. Perhaps they are placed there to chastise likely egg-stealers, including schoolboys.

A nest which deserves a place in any discussion of bird architecture is that of the social weaver-birds or grosbeaks. As their name indicates, these birds live together in flocks and have developed the social habit to a degree that is rare among birds, to such a point, in fact, that many individuals construct a common nest, or, to be more exact, they live in separate compartments under one roof. The entire edifice resembles nothing so much as an enormous umbrella. Sometimes it contains more than a cartload of grass, and over three hundred and twenty nests have been counted under a single shelter, each one containing a pair of birds bringing up four or five youngsters. The nests are built of a plant known as bushman grass, and they are always constructed in the branches of the camel-thorn acacia.

In the beginning, a single pair of birds build their nest, by hanging the leaves of the bushman grass on a suitable branch, and weaving and plaiting it till it forms a roof. Beneath this roof the actual nest is built. Other sociable weaver-birds join in the enterprise, and the edifice grows by degrees till it looks like "a mass of grass pierced by numerous holes," each hole being the entrance to a nest. At the end of the season, of course, the old nests are abandoned. When Nature again calls the birds to the duties of nest-building, they do not seek another site, but enlarge the last year's roof and build another layer or layers of nests round the old ones, after the manner of the new cells in a wasp's nest. Year by year the same edifice is used. Small wonder, then, that these nests frequently attain enormous proportions.

The weaver-birds and hang-nests are the eccentrics of the bird world, so far as their nests are concerned. Using wiry grasses and fibres, for the most part, they weave them so skilfully that they appear to be the result of the

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efforts of some higher intelligence than is to be found amongst birds. One and all are bizarre in shape. Bottle, pear and retort shapes are common, and some of the nests resemble hammocks. Some are more than mere nests, and form permanent abodes; many are double-chambered, one for the sitting hen, the other a resting-place for her mate, or a nursery for her chicks.

One of the most remarkable of these nests is constructed by the Baltimore oriole, a common American bird. It bears considerable resemblance to the housewife's string bag, being suspended by its rim from some favoured branch. The bird weaves vegetable fibres so skilfully in its construction that the substance of the nest resembles that of a straw hat in an unfinished state. Frequently wool and hair are woven into the nest to give it added strength. As the Baltimore oriole is not troubled with shyness, its building operations have been frequently observed. In the first place, it selects the strongest fibres it can find, and weaves them round the branches it has selected, to form the supports for its pendent nest.

On this foundation it builds up the rest of the structure and lines the whole with a layer of horsehair. "So solicitous is the Baltimore oriole to procure proper materials for his nest that in the season of building the women in the country are under the necessity of narrowly watching their threads that may chance to be out bleaching, and the farmer to secure his young grafts, as the Baltimore oriole, finding the former and the strings which tie the latter so well adapted for his purpose, frequently carries off both. Or, should the one be over-heavy, and the other too firmly tied, he will try at them for a considerable time before he gives up the attempt. Skeins of silk and hanks of thread have often been found, after the leaves have fallen, hanging round the Baltimore oriole's nest, but so woven up and entangled as to be entirely irrecoverable. Before the introduction of Europeans, no such materials could have been found



A BIRD-CATCHING SPIDER'S WEB.

This enormous Madagascar spider spins webs so strong that birds are caught and held in them. In one of the large meshes will be seen a small parasitic spider's web for catching flies and other insects. The smaller spider is not only permitted to do this, but is protected by its host from the attacks of the smaller birds.

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here; but, with the sagacity of a good architect, he has improved this circumstance to his advantage, and the strongest and best materials are always found in those parts by which the whole is supported."

We must leave the work of the weaver-birds and hang-nests with this scanty review and pass to nests in which mud plays its part in binding the nesting materials together. A common yet withal a good example of such a nest is constructed by the song-thrush. The greater part of the thrush's nest is composed of small stalks and grass, and in this it is in no way peculiar, but the interior of the nest is worthy of close study. The beautifully moulded cup of cow dung, despite its unpleasant associations, cannot fail to excite our admiration. As thin as the proverbial wafer, and of exceeding toughness, it is moulded and plastered with marvellous skill. By the heat of her own body the mother bird dries the lining, then, as though to protect her chicks from contamination, she adds a further thin lining of fine wood chips mixed with saliva, an actual lining of bird-made linoleum.

One might imagine that such a structure would be hard for the eggs and cold for the chicks; as a fact, it forms a first-rate incubator. The hen bird, when sitting, opens her wings slightly, covering the whole of the cup-shaped nest, which retains her body heat to a remarkable degree, thus making for the efficient hatching of the eggs. The blackbird builds a very similar nest, but covers its mud lining with a thin layer of grass.

The pied grallina, instead of lining its nest with mud, mixes this material with sticks, grasses and feathers, to form a very rigid plaster. Still more curious is the nest of the oven-bird. Like the pied grallina, it uses mud mingled with grass and various vegetable fibres, which is hardened by the sun's rays to the consistency of brick. The rounded, dome-shaped nest has a slit-like opening at the side, and although its thick walls are immensely

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strong, it is still further strengthened by a partition, also made of mud and grass. The inner chamber of the two-chambered nest is lined with feathers, and is used by the female for incubation purposes. The outer chamber appears to be a retiring-room for the male bird.

The common swallow and the house-martin are also mud-builders, familiar to us all. The latter bird builds a nest shaped like a half basin and usually attaches it to the wall of a building. Pellet by pellet it brings the mud to build its home. Beginning at the bottom, it, so to speak, constructs the base of its nest and, working upwards, it adds the rest piece by piece, allowing each addition to dry before applying another. Often straw and other vegetable matter is added to the mud for strengthening purposes, and the completed nest is lined with feathers and dry grass.

Curious indeed are the nests built by the edible swifts, for the sole material used consists of the bird's saliva. These nests are considered a great delicacy in certain parts of the world and a large trade has been built up in them—they are used for soup-making.

Mr Charles Dixon, the well-known ornithologist, gives a very good account of the collection of these nests: "The swifts arrive at the Andamans towards the end of November. Before the birds arrive a party of convicts and natives is sent round to all the caves which the birds frequent to clear away all the old nests and generally to clean the resorts. The birds appear to be in no hurry to commence nest-building, and the first crop of nests is generally a poor one, being soiled by the damp and the drippings from the roof of the caves.

"About the end of January the collectors visit the different caves—a journey which occupies about three weeks—in an open boat, and bring in all the nests that have been built. The best quality of these resembles pure isinglass, are worth their weight in silver and are found in the caves in limestone and volcanic rocks, those from sandstone being

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considered inferior. The birds now build much faster and at the end of February a second gathering takes place, which is usually the best of the season. The third collection is made in April, when the nests, though of good quality, are thin and dry. After this the poor birds are left in peace to build again and rear their young. The nests are very carefully removed from the rock with an iron trident, and are kept in clean linen bags, it being most important that they should not become soiled or wetted by sea-water. When brought into port, they are cleaned of all feathers and impurities, and then packed in bundles weighing about 4 lbs. each and graded according to their quality. The nests are divided into three classes, the first and best being pure white, the second clean but of a yellow colour, the third discoloured and mixed with feathers and other substances. These wonderful nests are formed from a gelatinous secretion from the salivary glands of the birds. Many of the caves, which are scattered about the islands and sometimes far inland or amongst mangrove swamps, are quite dark, torches and ladders being necessary to collect the spoil."

The dipper builds its neat, domed nest close to some stream, or sometimes, indeed, behind a waterfall, through which it must needs fly on its journey to and from the nest. The greatest care is taken in the building of this little home; it is neatly constructed of fresh moss which is kept in green condition by the spray from the nearby water.

Often the material of which a nest is made is of greater interest than is the nest itself; sometimes the form and material are both peculiar, and such is the nest of the fiery topaz. In shape it resembles a miniature cow's horn, with the point affixed to some slender branch. In material it appears to be made of leather and its nature for long remained a mystery. Seeing that it closely resembles the branch on which it is built, the first surmise was that

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the nest was some natural outgrowth of the tree, of which the bird had taken possession. But all these early guesses were wrong, as naturalists discovered when they watched the bird more closely. It was seen to search diligently over every tree near its home till it met with a fungus of the genus *Boletus*. Now this fungus, though soft, is tough and leathery, but the fiery topaz deftly moulds the uninviting substance into a comfortable, serviceable nest of marvellous craftsmanship.

A very remarkable nest, and one which forces itself upon our attention, is that of the great grey shrike. The bird seems anxious that we should all admire its handiwork, for it always builds in the most conspicuous places. Of the nest itself there is but little to say. It is large and rough and loosely built of moss, wool and grass, and its lining is of hair.

Of far greater interest than the nest is the larder with which it is always surrounded. Now the shrikes are peculiar amongst birds of prey, in that they always impale their victims on some nearby thorns. Accordingly the nests are invariably built in thorn-bearing shrubs, such as the blackthorn. Bees, beetles, even nestlings are the common stock of this avian larder. Why, exactly, these birds should have such curious habits is a moot point. Some say that they cannot eat any flesh till it has been well hung, but, as a fact, shrikes often kill and eat insects without impaling them.

A peculiar and erroneous story has been woven around the red-backed shrike, another familiar bird, to the effect that there are always nine impaled creatures round its nest, and that after eating one it always catches and impales another before venturing on a second meal. So deep rooted has this fable become that the bird is called the nine-killer in some parts of the country, in fact its scientific name signifies as much.

Formerly the great grey shrike was used in falconry, though it was held in little esteem. In an old sporting

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book the following amusing account is given of the method by which the bird captures its prey :—"Sometimes upon certain birds she doth use to prey, whome she doth entrappe and deceive by flight, for this is her desire. She will stand at perch upon some tree or poste, and there make an exceeding lamentable crye and exclamation, such as birds are wonte to do, being wronged or in hazard of mischief, and all to make other fowles believe and thinke that she is very much distressed and stands in need of ayde; whereupon the credulous sellie birds do flocke together presently at her call and voice, at what time if any happen to approach neare her she out of hand ceazeth on them, and devoureth them (ungrateful subtile fowle!) in requital for their simplicity and pains.

"Heare I ende of this hawke, because I neither accompte her worthy the name of a hawke, in whom there resteth no valour or hardiness, nor yet deserving to have any more written upon her propertie and nature. For truly it is not the property of any other hawke, by such devise and cowardly will to come by their prey, but they love to winne it by main force of wings at random, as the round-winged hawkes doe, or by free stooping, as the hawkes of the tower doe most commonly use as the falcon, gerfalcon, sacre, merlyn and such-like."

One of our summer visitors, the reed-warbler, is a beautiful and ingenious little nest-builder. Arriving in this country after the reeds are well grown and departing before they are cut, it lives, as a rule, a happy, care-free life. Still water and abundance of reeds provide this delightful little bird with all the necessities for an enjoyable life; for amongst the reeds it can find abundance of food and material for its nest, together with a suitable situation for its erection. The parent birds hunt the reed-beds till they find three or four reeds growing fairly close together. Having made this discovery, the work of nest-building commences. First of all the leaves of dried reeds are skilfully twined round the chosen reeds till they

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are firmly bound together. Then, working from below upwards, further additions of reed and tough grasses are cleverly interwoven with the supporting reeds, which act as scaffold poles. Eventually the little nest is completed, and a marvellous structure it is.

Anyone who has watched reeds blown and bent now here now there even in a slight wind must wonder that any bird should select so frail a support for its nest. The reed-warbler, however, builds a nest that is proof against all but the most violent storms, for it is remarkably deep for its size and, as it sways in the wind till it lies almost horizontally, the eggs ride securely in its depths and are in no danger of falling out.

Before we pass to the consideration of birds' eggs and their peculiarities we must, perforce, mention one skilled architect if only for the fact that its activities are so extraordinary and so different from those of all other birds. We refer to the tailor-bird of India. This little bird tailored its leaves long years before man wore clothes. We wonder if man learned the art from this humble bird as he admittedly has done in other cases from other animals lower in the scale than himself.

The tailor-bird builds its white, cottony nest either in the folds of a single leaf or between two or more. Whether one or more leaves are used, it is necessary for the bird to make a funnel to hold its nest. To accomplish this, either the two edges of a large leaf must be fastened together or the edges of more than one leaf must be joined, and the bird accomplishes this by sewing the leaves. Using its beak as a needle, it bores a number of holes along either edge of the chosen leaf; then, having provided itself with thread, in the shape of plant fibres, with beak and feet it brings the two edges together and sews them up. Some of these birds take the greatest care in sewing their leaves from tip to base, others insert a few threads here and there, but in any event the result is the same: the original flat leaf is fashioned into a cone. Should the bird not

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be able to find a leaf of sufficient size to hold its nest, or two leaves so near to one another that they can be sewn it will pluck a leaf from a neighbouring tree and sew it to the leaf it has selected. Most remarkable of all is that the bird, like an efficient sempstress, knots the end of the fibre to prevent its pulling through the holes in the leaf or leaves.

CHAPTER XI

BIRDS' EGGS

WHEREVER and whenever birds and their nests are discussed it is fitting that something should be said about their eggs, and for this reason: looked at in the proper light, they teach us a great deal about the birds themselves. All healthy-minded schoolboys, and many grown-up boys, have collected birds' eggs, some from the mere pleasure of plundering a creature weaker than themselves, many because of a genuine love of nature and all that it implies, and a few, thanks no doubt to the encouragement of a school or local natural history society, with the object of gaining a real knowledge of bird life. Of all these collectors, how many, we wonder, look upon their prizes in the light of bric-à-brac, or foreign stamps or cigar bands or cigarette pictures or any of the other hundred and one things that lend themselves to collection, and how many try to learn something of the habits and nature of the birds that laid their treasures.

The association of the egg and its producer is more intimate than might be expected. We all know a duck when we see it, despite the fact that it may belong to a species we have never seen before. Birds of prey, too, cannot be mistaken for any other birds; their hooked beaks and well-developed talons give away their profession. The snipe and its family also bear a striking resemblance to one another, and the list might be extended *ad nauseam*.

Just as these birds possess certain peculiarities of structure which mark them out from all other birds, so do their eggs, and the eggs of many other birds. A very slight acquaintance with them will enable the student to say at once that any particular egg was laid by a duck, a grebe,

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a hawk, an owl, a plover, as the case may be ; and, what is more, the experienced man can say something of the nest in which a particular egg was laid. We hope to show how this may be accomplished and also that there is more in an egg than meets the eye—sometimes there is a good deal more, but that is another story.

The sizes of eggs, needless to say, vary enormously—from those of the extinct *æpyornis*, the contents of whose egg measured at least three gallons, to the tiny egg of the humming-bird, a striking contrast indeed. Confining ourselves to present-day eggs, the contrast between the largest, laid by the ostrich, and the smallest, that of the humming-bird, there is an enormous difference. The size of an egg does not, of necessity, bear any strict relationship to the size of the mother bird—that is to say, if we had twelve eggs of various sizes and arranged them in the order of their sizes, we could not say of a certainty that the birds if arranged according to size would come in the same order as the eggs. The kiwi, for instance, lays an enormous egg for its size, one quarter as large as itself, in fact. The snipe and the blackbird are about the same size, yet the egg of the former is very much larger than that of the latter. For this reason it is unsafe to predict the size of a bird from the dimensions of its egg, as has been done in the case of certain fossil eggs of extinct birds. Some of these eggs are of gigantic proportions, as we have mentioned earlier, and surmising that the mother must be as large in comparison, geologists have described imaginary birds too large to be credible.

The numbers of eggs laid by any one bird vary as much as their sizes. Certain birds lay but a single egg, the puffin and the hornbill for example. Many birds, like the nightjar and the pigeons, confine themselves to a couple. At the other extreme are such birds as the kingfisher and the wryneck, the former of which will lay its own weight in eggs should occasion arise, whilst the latter has been known to lay as many as forty-three eggs. But these are

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exceptional cases, and such prodigious fecundity only occurs when mishaps overtake the first-laid eggs. In the ordinary case, the partridge, with a complement of about sixteen eggs, will suffice as our example of a good layer.

The domestic hen, of course, surpasses even the wryneck, but then it does not live under natural conditions, so must be left out of our reckoning. Here we may fitly add a remark anent one of Nature's laws to which there are few if any exceptions. The number of eggs laid by any bird in a single season is roughly proportional to the chance those eggs have of developing into adult birds. The puffin, as we have said, lays a single egg. This is hidden away in a burrow constructed by the parents, who are well able to take care of themselves and their young.

The wryneck, though so remarkably prolific, is a rare bird with us; we may conclude, therefore, that the mortality amongst wrynecks is heavy. "Its struggle for life is undoubtedly a severe one, and its great fecundity most probably saves it from complete extinction." The domestic hen, finding its eggs were removed as soon as they were laid, made persistent efforts to raise some offspring. This happened so frequently in the early days of its domestication that it became a habit, at least man intended it so, but poultry-keepers know, only too well, that the hen is fickle and frequently does not reward its owner in the way it should.

The surface texture of eggs is the next point to be noticed, and in this again they vary considerably. The majority are matt, shall we say midway between rough and smooth. There are all sorts of variations of surface, from the exceedingly rough shell of the egg of the emu to the very highly glazed product of the tinamou. Between these extremes we have the pitted eggs of the ostrich; but these eggs are variable amongst themselves; some are almost smooth, some deeply pitted, and naturalists say that the birds laying smooth eggs do

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not belong to the same species as those laying pitted eggs. Certain birds' eggs are covered with a chalky deposit.

We are now confronted with the two most important points about birds' eggs, their shapes and their colour. Let us speak first of their shapes. The contour of an egg is almost invariably a certain guide to the group to which the bird who laid it belongs. Thus all the owls lay round eggs, and so do kingfishers ; penguins and nightjars lay oval eggs ; those of plovers and sandpipers are sharply pointed at one end, whilst grebes' eggs are pointed at either end. Why should there be all these different shapes ? Well, we can only give a few instances to show that the shape of an egg is not a mere coincidence, but is carefully designed for a special object.

Take a hen's egg and try to roll it along a smooth surface. It will roll certainly, but it tends to describe a circle. The hen's egg is slightly more pointed at one end than the other, a fact which accounts for its not rolling straight. The plover's egg is much more pointed than the hen's, and it will not roll in any other manner but in a circle, a fact which serves the parent bird's purpose admirably, for, being laid in a flat, shallow nest on the ground, it is most important that the eggs should not roll away when the sitting bird is suddenly disturbed from her nest. Owls and kingfishers, on the other hand, lay round eggs which will roll easily, but as these birds nest in holes there is no need for any provision to be made against their doing so.

The most important and most striking characteristic of birds' eggs is their colour. Now these colours are not lavished by Nature for the mere purpose of decoration. Most of Nature's workings, perhaps all of them, serve an end, though it is sometimes difficult to read the book of nature. The colours and markings of eggs, as is the case with birds' plumage, is largely subordinated to the consideration of protection. For our purpose we may

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divide all eggs into two great groups, the spotless and the spotted. Probably in the long ago all eggs were white. As the need for protection became more acute, various shades and tints came into being, and then, for the purpose of further protection, arose the speckled, spotted, blotched and veined eggs which abound everywhere at the present day.

Let us consider the first of our great groups, the spotless eggs. We have mentioned that colour in eggs is a means of protection; what more natural, then, than to find that white eggs are almost invariably laid by birds which nest in holes or make domed nests. Most owls, and all woodpeckers, tree-creepers, wrynecks, kingfishers, sand-martins and puffins nest in holes, and all lay white eggs. The dipper, too, lays white eggs in its domed nest, and the grebes, on the other hand, despite the fact that their nests are flat, open structures, also lay similar coloured eggs, and may appear at first sight to be exceptions. To a certain point they are exceptional, but, as though to hide their guilt, these birds always cover their eggs with vegetation when they leave their nests. Wrens and tits, although they construct covered nests, do not lay pure white eggs, but slightly spotted ones, for the reason that their eggs are not so perfectly hidden from view, as a rule, as are those of the true hole-builders. In this connection, an interesting comparison may be made between the eggs of the closely related swift, house-martin and swallow.

The swift and house-martin build covered nests with minute entrances thereto and, as might be expected, their eggs are white; the swallow, on the other hand, makes a more open nest and, as is fitting, its eggs are spotted. This brings us to another interesting point. Birds of brilliant plumage rarely lay brightly coloured eggs, nor are such birds as a rule gifted with great vocal powers. The sweet-voiced nightingale could hardly be arrayed in more sombre plumage, whilst the gorgeously

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arrayed parrots can hardly utter a note which could be called musical, except through their extraordinary powers of mimicry. It is also noticeable that brilliantly coloured birds usually nest in concealed positions, for their own better protection during the days of incubation. Kingfishers, parrots and woodpeckers bear out our statement.

It is rare to meet with a rule without exceptions, and there are exceptions to the rule that white eggs are laid in covered nests. Most ducks lay nearly white eggs in open nests; partridges and pheasants lay eggs of such a colour that they are easily distinguished from their surroundings, and their nests are exposed to the prying eyes of beast and man. Herons, cormorants and storks all lay light-coloured eggs in open nests also, and the short-eared owl deposits her white eggs upon the ground.

Why should there be these exceptions, and how is it that the conspicuous eggs do not all come to an unfortunate end? The short-eared owl, for instance, is remarkably well protected by reason of the close resemblance of its plumage to the vegetation of the places in which it nests; moreover, the bird is an exceedingly close sitter, so that the mother herself protects her conspicuous eggs, and danger is thus avoided time and again. Herons, cormorants and the like are gregarious and nest in company, a fact which renders their eggs less likely to come to harm. Ducks, pheasants and partridges, like the grebes we have already mentioned, laying conspicuous eggs in fully exposed nests, all take the precaution of covering their eggs with vegetation harmonising with their surroundings before they leave their nests. It has been said that they do so in order to keep their eggs warm, but a study of the habits of the birds will show that they cover them before they have started sitting, before, therefore, the necessity for warmth has commenced.

Of the spotted eggs, we find that those with a greenish ground colour are usually laid by birds which nest in the early spring, amid green trees and shrubs. Thrushes, black-

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birds and crows are of these. Just as we found white eggs in open nests, so we find spotted eggs in concealed nests. Nature would not be half so interesting if she did not treat us to these apparent anomalies. The magpie, despite its elaborate domed nest, lays spotted eggs; the jackdaw, which builds in holes, has very similar eggs. In both these cases the eggs are much paler than those of closely related birds which build in open nests, so it is reasonable to suppose that with the passage of time there will arise magpies and jackdaws capable of laying spotless eggs.

A few words concerning the protective colouring of eggs may not be out of place. Let us begin with those of ground birds such as the nightjar, skylark and meadow-pipit, all of which harmonise marvellously with their surroundings, and those of the nightjar may serve as our example. This bird has brought concealment to a fine art; even its manner of perching on a tree branch is designed to render it as inconspicuous as possible. Other birds perch across the branch. Not so the nightjar. Selecting a broad branch, he perches along it, and, what is more, crouches low upon it. In this position detection is wellnigh impossible, he harmonises so well with his surroundings.

The female nightjar, often called the fern-owl from her supposed resemblance to an owl and her habit of frequenting bracken, lays two eggs upon the ground, usually at the base of a fir-tree or under a furze bush, and sits them closely. But even when the mother bird is disturbed, her eggs so nearly resemble their surroundings that they are adequately protected. Pure white, mottled and veined with red-brown and grey, they are amongst the most beautiful eggs of any British bird, and also some of the most variable, no two being quite alike. Curiously, should mishap overtake the first-laid eggs, the nightjar makes another attempt at housekeeping, but this time she lays only a single egg.

Here, in imagination, we have two eggs before us.

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With their sizes and shapes we are not concerned ; it is their colours alone that interest us for the moment. The one, a neat little egg, is dark cream in colour, spotted with grey and brown ; the other is not altogether dissimilar, but the fine spots are wanting and in their place we observe large, bold blotches. We have been told, and rightly so, that both these birds nest upon the seashore. How, we may well ask, can eggs so diverse in general markings both be protected by their colour ?

Let us place the first egg, the one with the fine dots, on the fine sand and observe that it is most difficult to isolate it from its surroundings. The ringed plover, which laid the egg, always selects fine sand for its nest. Now let us take the other egg, the boldly marked one, higher up on the shore, almost to the line where sand and shingle meet, where a miscellaneous collection of the leavings of the sea lie scattered here and there. Let us place our egg on this ground and notice that it is even more difficult to find than the other. The second egg belongs to the lesser tern, which nests where sand and shingle meet.

In almost every species of bird there is a reason for the colour or shape of its eggs. We could quote example after example of eggs designed to harmonise with their usual surroundings. Hawks' eggs usually resemble the lining of the nest, and the eggs of the common house-sparrow harmonise so well with the feathers with which it upholsters its nest that they are by no means easy to detect. Occasionally, however, some foolish bird will build its nest in such a position that its eggs by their very colour and markings are rendered conspicuous. What is the result of such daring ? Calamity befalls the home in the majority of cases and the law of the survival of the fittest holds sway. Foolish birds are not encouraged by Nature to beget other foolish birds.

It is often difficult to account for the colouring of eggs ; we have mentioned a few of these puzzling cases already. The common guillemot lays but a single egg each year,

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or, to be more correct, rears but one chick, for, with a persistence that is worthy of emulation, the female guillemot will lay egg after egg as each one meets with mishap, till in the end she accomplishes her object of bringing another guillemot into the world. The eggs are remarkably variable; white, cream, sea-green, pale blue, red-brown, dark blue and yellowish-green ground colours predominate, and they are marked with dots, blotches, streaks and zones of colour, which may be black, brown, green, yellow or pink. In short, there is, between limits, hardly any colouring or pattern that may not be found in the guillemot's egg. The birds that lay dark green eggs in their first season will always lay dark green eggs all their lives; other birds will always lay blue eggs, and so on.

Surely these brightly coloured, bizarre eggs must be very conspicuous, someone will say. They are conspicuous, but that does not matter very much, for the guillemot lays its eggs on narrow ledges of rock jutting from wellnigh inaccessible cliffs. Were the bird to nest upon the ground its striking eggs would bring about its extermination in a very short time, for it has not the advantages of the woodcock, which lays conspicuous eggs.

Now the woodcock is a bird whose plumage matches its habitual surroundings about as closely as it is possible for two dissimilar objects to match, yet the bird lays an egg that could hardly be overlooked. Apparently the bird is conscious of its failing, for few sit more closely, in fact it is almost possible to step on a sitting woodcock before she leaves her nest. And the reason for her close-sitting habit is that her drab plumage may conceal her all too conspicuous eggs.

CHAPTER XII

PLUMAGE AND ITS MEANING

ALTHOUGH it may be comforting to think that the brightly hued birds of the earth have been placed thereon, by some all-seeing Providence, for man's especial delight or woman's adornment, a little thought will show that this is by no means the case. In general, the colours of birds are either designed as a means of protection against their enemies or of recognition by their own kind. Let us look at the matter impartially under these two headings, but before doing so we will say a few words anent the colours of nestlings.

Now it is a peculiar fact that chicks when first hatched usually have a spotted or striped livery, and various theories have been propounded to account for this fact. An ingenious though much debated theory is to the effect that the longitudinal markings serve to render nestlings less conspicuous amongst herbage with long, narrow leaves—grasses and the like. Spotted nestlings, on the other hand, are presumed to harmonise better with nests liable to circular shadows from more rounded leaves. And the propounder of this theory supports his case with the statement that "strongly spotted forms mostly occur in places with spotted shadows, the longitudinally striped in more grassy regions. Cross marking is perhaps to be connected with the shadows, for example, of the branches of woody plants—thus the marking of the wild cat escapes notice among the branches of trees."

The great naturalist Wallace, who gave much of his time to the study of this subject, said that "Protective coloration, in some of its varied forms, has not improbably modified the appearance of one half of the animals living

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on the globe." In studying protective colouring we must always keep one point in mind above all others. A bird, or a quadruped or a reptile, divorced from its usual haunts, may be so brilliantly coloured as to attract the eye inordinately, whereas the same creature in a state of nature may by the very brilliancy of its hues be rendered inconspicuous.

The kingfisher, as he sits motionless on his bough above the water watching intently for his finny prey, is wellnigh invisible; only when he takes to flight does he become conspicuous. The brilliantly coloured sun-birds are almost dazzling in their brilliancy when viewed as captives in a cage, but flitting from one bright flower to another in their native haunts they defy the detection of even the keen-eyed hawk.

When next we visit the Zoo or anywhere where there is a large collection of birds let us note that green is the prevailing colour, and, to carry our investigations a little further, we may observe that nearly all these birds are natives of tropical countries where the vegetation is always green. Parrots, barbets, woodpeckers and some pigeons are examples that come readily to mind. As we pass to birds dwelling in more northern latitudes, we notice a considerable sobering down of colour, greys and browns predominating. Shore birds, moor birds, desert and marsh birds are all coloured in such a manner as to harmonise marvellously with their surroundings, and it does not require any deep study to realise the truth of this assertion.

In the game dealer's window the cock pheasant makes a brave show—he is one of the most gaily attired of our native birds; in his woodland haunts his bright hues merge astonishingly into the general colour scheme of the grass and russet leaves of the vegetation amongst which he struts. The woodcock, as we have remarked elsewhere, is wellnigh indistinguishable amongst the bracken. The thrush, hopping over the tennis lawn, pausing from time to time listening intently for the sound

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of a worm coming to the surface, is quite conspicuous ; as he perches in the shadow of some nearby shrub, even the vigilant cat may pass him by unnoticed.

Desert birds are, with, we believe, a single exception, all sand-coloured. Some of them so closely resemble their surroundings that they rarely seek safety in flight, but crouch on the sand and rely on their resemblance to the desert soil for safety. Often very interesting modifications of plumage to suit the surroundings may be observed in the same species of bird. On this subject, a well-known naturalist, writing of the crested larks which he observed during a journey from the Algerian coast to the desert, remarks: "They gradually became browner and browner in plumage as we left the cultivated districts behind and entered the Sahara, until on the actual desert itself the individuals of this species presented a rich sandy brown hue, so utterly different from the colour characteristic of the cultivated coastlands that naturalists have separated them into several well-recognised races."

Shore birds are equally well protected as regards colour. The little ringed plover, who so cunningly conceals its eggs, is a good example. Conspicuous as this natty bird appears when divorced from its haunts, it is difficult to detect as it runs hither and thither on the shingle by the seashore. We have often observed these conspicuously marked birds alight on an expanse of shingle and have searched for them through powerful field-glasses without being able to detect their whereabouts, yet one would think that their black and white markings would show up well. Even the brightly hued oyster-catcher is well camouflaged as he goes about his business on the shore. Many of these shore birds nest inland and at that season assume plumage which would render them plainly visible on the sand and shingle. The knot and dunlin have this habit, but after the nesting season they always don their sombre garb so that they may fish unmolested by the sea during the summer and autumn months.

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Marsh birds, such as snipe, bitterns and corn-crakes, are amongst the most remarkably protected of all birds, as far as plumage is concerned. Flecked and striped as they are with alternate dark and light shades of colour, they harmonise in a wonderful manner with the green and russet-brown grasses and sedges which they haunt. The common bittern—we call him common to distinguish him from other bitterns, though, as a matter of fact, he is nearly extinct in Britain—presents, probably, the most remarkable example of protective colouring in all birdland. His plumage, as befits his habits, is exceptional amongst the herons. Sulking in reed-beds, he is well clothed for the life he has chosen. His breast is a pale fawn striped with brown. When he wishes to escape detection, he raises his head aloft and points his beak to the sky, so that his striped breast is well exposed. In this position he remains motionless, and it would be a keen eye indeed that could say certainly which was the breast of the bittern, which the russet-brown herbage.

On the moors the same tale is repeated. The red grouse, a bird which never ranges beyond the confines of Great Britain, with his mottled red-brown coat, harmonises exactly with the ling and heather of his native moors; and well he knows it, for when surprised by the roadside or on grassland, where he often goes to sun himself, his first impulse is to reach the heather, which matches his plumage so well that the risk of detection is much lessened.

Marvellous are the changes of raiment which the ptarmigan assumes to suit the ever-changing seasons. As one writer has stated, the bird seems to be in a chronic state of moulting. "In the spring the ptarmigan is clothed in a dress of dark brown mottled with yellowish-brown tints in beautiful harmony with the mosses and lichens. In autumn the bird changes this dress for one of pale grey vermiculated with black; or rather it is slowly changing colour all the summer through with the changing

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aspect of its haunts, the latter tints being emphasised at a time when the scanty vegetation is scorched up and beginning to fade. Then comes the period of the winter snows, when the mountain-tops are draped in a white pall which hangs over them until the following spring. But the ptarmigan again changes its dress and the browns and greys are discarded and a plumage of dazzling whiteness assumed in their place. White ground and white birds harmonise together, and the ptarmigan lies safe in its disguise until, with the melting of the snow, his browns and yellows are resumed with the changing year and the cycle of plupal change is complete."

In the Arctic regions many birds assume this summer plumage. The willow grouse is dressed in brown during the summer and assumes white raiment for the winter. The snowy owl and Arctic falcon have permanently white apparel. The snow bunting, who frequents the droppings of animals, is black and white, an admixture which owing to his peculiar habits renders him less conspicuous than would be the case were he pure white. A curious case is that of the jet-black raven, who retains his funeral garb even in the Arctic circles, and so becomes a conspicuous object. But the raven is well able to take care of himself and requires no plupal aids to help him through the world.

Having briefly reviewed various avian liveries which are obviously designed for the protection of the wearers, let us pass to certain bright markings which render their owners conspicuous and for a purpose. What is the object of these showy markings? Their possessors are birds which live in flocks for the most part, and the conspicuous markings of the individuals serve a useful purpose as identification marks for those birds which may stray from the flock. In addition to their garb, these gregarious birds usually give vent to certain call notes, with the further object of enabling the members of the flock to keep in touch with one another. A party of long-tailed

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tits, for instance, on hunting bent, keep up an incessant twittering all the while. Should one, more fortunate than his fellows, come upon a plentiful supply of food, he raises his voice as a signal to the others to share in his good fortune.

Some of our commonest finches, moderately brightly marked, when viewed at close quarters, are decidedly inconspicuous as they hop from branch to branch of some favoured tree, so much so that even the experienced bird-man may have some difficulty in distinguishing them from others of a different species. One glimpse of these same birds on the wing and their identity is unmistakably revealed: the green-finch by his golden wing bands, the chaf-finch by his black and white markings, the bull-finch by his white rump. It is certain that these identification marks serve the birds themselves in good stead when they desire to keep in close company. The common sight of a couple of bull-finches hunting in company, the one following the other from tree to tree, tells us as much if we can read nature aright. Jays, again, are barely distinguishable from their surroundings when not in flight, but once their wings are spread, the conspicuous blue marks thereon proclaim their identity far and wide. Ring-doves also give themselves away in flight by the white markings on their wings.

Of conspicuous tail markings there are plenty. We have already cited the white rump of the bull-finch. The common and the black redstart have similar tail markings. When their tails are folded, only sombre colours are visible; in flight, however, with tails spread, a bright chestnut recognition patch is displayed.

The white, upturned tail of the rabbit serves a useful purpose, though it also provides a good mark for the sportsman armed with a gun to the rabbit's undoing. As the rabbit makes for its burrow when alarmed, the tails of the foremost animals serve as guides for those behind, enabling them to seek shelter with the least possible

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delay. Amongst birds an almost parallel case is afforded by the water-hen: the under side of this bird's erect tail is white. The peculiar and constant flicks which the water-hen is in the habit of giving to its tail seem to render it unduly conspicuous. It is a shy bird, only venturing from its reedy haunts to the open water when it feels certain that there is no risk of danger and when the calls of hunger compel it to do so. On the least alarm it darts for cover and is soon lost to view. Birds of its kind on a hunting cruise, seeing the white tail making for shelter, take the hint and beat a hasty retreat, without loss of time. Seeing that the water-hen usually ventures in the open towards evening, its white tail serves as a better guide, in the failing light, than would any other colour.

There are recognition or identification marks innumerable in the bird world: it is easy to pick them out and forms a fascinating study. A striking point, yet a natural one, is that in almost every instance they can best be seen when the bird is viewed from behind. Birds flying towards one another do not need these marks; it is the bird that is left in the rear which requires assistance in catching up its fellows. "This recognition is of the most vital importance when upon it depends the keeping together of a bird or flock, the following of the parent by the young or the close association of the sexes, either for reproduction, mutual protection or search for sustenance or lastly the quick following of some conspicuous leader to a safe refuge when threatened by danger."

Of the brilliant and often bizarre plumage assumed by birds in the mating season we have something to say in our chapter on Courtship. The feathers which make up a bird's plumage are not all of the same kind, and the down of nestlings is obviously vastly different to the quill feathers of the adult bird, but we are not concerned with questions of structure.

There is, however, one kind of feather, which only occurs on certain birds, of so peculiar a nature that we

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must give a few words to it. These feathers, known as powder-down, are so constructed that at the slightest touch they break up into a fine white powder. This powder-down is to be found on parrots, herons and hawks, and its use is not fully understood. "There is a tradition—quite unfounded—to the effect that in the heron tribe this powder-down is luminous, and that the birds take advantage of luminosity by raising the contour feathers so as to shed this light on the water wherein they may be fishing, and thereby lure their prey to within striking distance. As these birds do not fish by night, and the glow would be invisible by day, this theory may be regarded as exploded."

CHAPTER XIII

COURTSHIP

COURTSHIP and animal ingenuity, how can they be reconciled? A little time spent in the consideration of a few examples of courtship amongst birds and some beasts will supply the best answer to our question. The courting swain, about to visit his sweetheart, doffs his working clothes if he be a wise man and dons his Sunday best, which, though probably of more striking appearance, frequently do not befit him so well as his workaday garb. She on her part is lavish with her finery, according to her means and taste; her favourite perfume, too, is not forgotten. The young couple—sometimes they are old and then they are more foolish—bedeck themselves thus that they may appear more attractive in the eyes of their respective lovers. Savages suffer from the same complaint in more or less acute form and the habit has its counterpart in the animal world.

Finery, sometimes grotesque in its extravagance, scent, weird antics, all play their parts in the attempt to attract the opposite sex. The weaver-birds, builders of curious flask-shaped nests, in winter-time are no more brightly attired than sparrows; but when the male is about to take a mate he assumes gorgeous raiment which renders him an Adonis among birds in the eyes of the hen. The cock wydah birds at this season develop tails of such unwieldy proportions that flight is rendered difficult, and for the same reason.

Song also plays its part in the amorous competition. True, the lovers' notes are not always pleasing to human ears, but they are evidently enchanting to the hen birds. The cuckoo is a case in point. When he seeks a mate his

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well-known call note may be heard in the land by all who deign to lend an ear. His purpose accomplished, his voice becomes harsh, a mere croak in fact, and at times he literally stammers. It is utterly impossible to give voice to his cry in his pre-mating manner.

Weird dances, a swaggering gait, even extraordinary contortions are all part and parcel of the allurements spread to catch a mate. Man has seized upon this peculiarity and developed it to his own ends. The common pigeon, on love-making intent, puffs out his crop, the better to exhibit the fine feathers of his neck and breast to the admiring gaze of his lady-love. By careful selection a race of pigeons, known as pouters, has been evolved. These pigeons are able to make their crops swell to enormous proportions; they are simply deformities; though, of course, pigeon fanciers will not be with us on this point. The males of other birds are often particularly attractive in their colouring; the peacock is one of these, and they are many. Most interesting of all, perhaps, are those birds which build houses and bring presents for their future wives, and this, indeed, is the fashion amongst the bower-birds.

Having viewed the matter thus far, can we deny that, consciously or unconsciously, male birds exhibit a high degree of ingenuity in their attempts to attract the opposite sex? With the females the case is often different, for many of them are coy and blasé in turns when in the presence of their mates, whose annoyance at their seeming indifference is frequently ill concealed.

Courtship among birds is interesting to the outsider, who is said to see most of the game; moreover, it has been more closely studied and is therefore better known than is the same phase in the lives of any other members of the animal kingdom. Certain fishes also assume brilliant hues at courting time. A few insects, some spiders, scorpions and crabs are eccentric in their love-making, but it is to the birds that we must turn for gorgeous

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display, weird dances and extraordinary vocal efforts. The higher animals, curiously enough, are often brutal in their love-making.

Of all birds, the most extravagantly arrayed are the birds of paradise; sometimes, indeed, they are bizarre in their adornment. For dazzling beauty, few can compare with the king bird of paradise. Sad to relate, his beauty has cost him dear, for he is no stranger to the wardrobe of, shall we say thoughtless, ladies, who never give one moment's thought to the fact that to satisfy their vanity there must be one of Nature's living gems the less in the world.

The king bird of paradise is not a big bird, hardly as large as a wood pigeon in fact. Of a rich vermilion colour, with an orange head and a white breast barred with shimmering green, light blue legs and a pair of wire-like tail feathers nearly a foot in length and each terminated by a special coil of vivid green, he cuts a striking figure.

For an account of the curious courtship displayed by this jewel of a bird we make no excuse for quoting Sir William Ingram, for he has kept the king bird of paradise in captivity and frequently observed his behaviour. Sir William says: "He always commences his display by giving forth several short notes and squeaks, sometimes resembling the call of a quail, sometimes the whine of a pet dog. Next he spreads out his wings, occasionally quite hiding his head, at times, stretched upright he flaps them, as if he intended to take to flight, and then, with a sudden movement, gives himself a half turn, so that he faces the spectators, puffing out his silky white lower feathers; now he bursts into his beautiful, melodious, warbling song, so enchanting to hear but so difficult to describe.

"Some weeks ago I was crossing a meadow and heard the song of a skylark high up in the heavens and I exclaimed at once, 'That is the love chant of my king bird.' He sings a low babbling note, displaying all the

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while his beautiful fan-like side plumes, which he opens and closes in time with the variations of his song. These fan plumes can only be expanded when his wings are closed, and during this part of the display he closes his wings and spreads out his short tail, pressing it close over his back, so as to throw the long tail wires over his head while he gently swings his body from side to side. The spiral tips of the wires look like small balls of burnished green metal, and the swaying movement gives them the effect of being slowly tossed from one side to the other, so that I have named this part of the display the juggling. The swaying of the body seems to keep time with the song, and at intervals, with a swallowing movement of his throat, the bird raises and lowers his head. Then comes the finale, which lasts only a few seconds. He suddenly turns right round and shows his back, the white fluffy feathers under the tail bristling in his excitement; he bends down on the perch in the attitude of a fighting cock, his widely opened bill showing distinctly the extraordinary light apple-green colour of the inside of his mouth, and sings the same gurgling notes without once closing his bill, and with a slow dying-away movement of his tail and body. A single drawn-out note is then uttered, the tail and wires are lowered, and the dance and song are over.

"The king bird has another form of display which he very rarely exhibits, and only on three or four occasions have I seen him go through this performance. Dropping under the perch, the bird walks backwards and forwards in an inverted position with his wings expanded. Suddenly he closes his wings and lets his body fall straight downwards, looking exactly like a crimson pear, his blue legs being stretched out to the full length and his feet clinging to the perch. The effect is very curious and weird, and the performance is so like that of an acrobat suddenly dropping on to his toes on the cross-bar of a trapeze that I have named this the acrobatic display. It has been witnessed on different days to his juggling

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display. While giving his acrobatic display he sings the whole time, but never shows his side plumes, and when he is in the pendulous position his body sways gently as if it were influenced by a fitful breeze. The whole of this performance takes but a very few seconds."

From the bejewelled king bird of paradise to the relatively sombre great crested grebe is a far cry as far as appearance is concerned. The male king bird performs his strange rites to attract his mate; both male and female grebe take part in the eccentricities of love-making. Many years ago we remember witnessing this avian pantomime of the grebes, on a Midland mere. At that time we did not fully understand the purport of the birds' behaviour. The male and female grebe are as similar in appearance as the proverbial two peas. Their necks are ornamented with a light brown ruff and their heads with darker brown feathers of such a nature as to give them the appearance of being eared; their breasts are snowy white.

At the time of courting, when the grebes, maybe, are quietly feeding on some secluded waterway, a pair will suddenly face one another and begin wagging their heads from side to side. After a moment or two of this pantomime the male bird dives, but his mate still wags her head. Her companion then rises slowly and gently from the water in front of her. At first only his head appears above the water level, but by degrees his back, his body, all of him in fact, is displayed to the admiring gaze of his spouse; a few more head-waggings and courtship gives place to the more material business of seeking food. At times this strange procedure is varied by antics more extraordinary. As usual, the head-wagging preliminaries are indulged in, then both birds dive and remain below water for a short time, eventually coming to the surface some distance apart, when they contrive to lie almost prone upon the water. Next they travel rapidly towards one another, and when they have almost collided both

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rise into an erect position with beaks, in which a piece of water weed is held, nearly touching. Tiring of their performance, they cast away their burdens, resume their head-wagging for a time and eventually return to their feeding. The comical antics of these whimsical birds may be aptly described as one of Nature's pantomimes.

Another curious performance is enacted by the ruffs. By a strange coincidence the ruff, like the great crested grebe, has feathery "ears" and a voluminous ruff—from which he takes his name—just behind his head. Perhaps these "eared" birds, by reason of the unusual arrangement of their feathers, appear more eccentric than they would do were they more normally clad. The ruff is a long-legged, long-beaked bird, closely related to the snipe, and is peculiar in the fact that no two individuals are ever exactly alike, in colour or in markings.

The courtship in these birds begins with a tournament on the part of the males for the possession of the females—each ruff may have several wives. Very early in the morning, just about sunrise, in fact, these tourneys begin. A couple of ruffs will puff out their neck feathers, face one another and stand perfectly motionless, with the tips of their long beaks resting on the ground. After a period which appears unduly prolonged they attack one another, but not very fiercely, their object, apparently, being not to cause bloodshed, but simply that one of the suitors should be driven from the field. The more courageous ruffs, having got rid of their rivals, compete for the favours of the hens. The ruff is a persistent suitor, and he need be, for a more blasé mate than the hen bird, or reeve as she is called, it would be hard to find.

Time and again the male will force his attentions on his mate, only to be as frequently rebuffed. He displays his "ears" and ruff to the best of his ability before the lady bird and rests his beak upon the ground the while he appears lost in thought; she, on her part, will as likely as not run or fly away before her mate has completed

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his day-dreams. Then the hunt begins again, and the performance is repeated many times, till, eventually, doggedness has its reward and the ruff wins his lady-love.

The ruffs are not the only birds that select the chill hour of sunrise for their amatory displays; prairie hens hold meetings at the same hour. The cocks and hens collect together at some spot which is evidently pre-arranged and the performance commences with a display of finery by the males, who are adept at exhibiting themselves to the best advantage. Shall we call them the mannequins of the bird world? Up and down they strut for the admiration of the hens. But this dilatory parade soon becomes wearisome to the excited males; so, to enliven the proceedings, they rush pell-mell amongst their admirers, uttering loud cries the while. As the sun arises well above the horizon, the party breaks up, but the performance is repeated morning after morning for, maybe, a fortnight. Towards the end of this time the friendly rivalry of the males gives place to fierce competition for the favours of the hens and eventually to fighting.

The peacock displaying his tail coverts in the presence of his mate is merely showing her what a fine fellow he is, and it must be admitted that he makes out a very good case for himself. With his body inclined forwards, and his brilliant tail coverts thrown over his wings so that only they and his head and neck appear from the front, he makes a brave show, which his spouse does not always fully appreciate, in fact we have seen her making up to another male at the time, totally disregarding the exhibition prepared for her benefit. While he is actually courting his wife, he is rude enough to walk backwards towards her, and not without reason. His back view is sombre in the extreme compared with the other side of the picture. When close to his mate, he wheels round with astonishing rapidity and faces her, and, as though

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to draw attention to his dazzling brilliancy, thus suddenly displayed, he literally rattles his long tail coverts and lowers his head in respectful homage. The ill-mannered hen usually ignores his efforts to win her affections.

The bower-birds, which are related to our common starlings, are among the most curious of birds, as far as their behaviour is concerned. The males build wonderful shelters of sticks and other material and ornament them for the benefit of the hens they hope to win. By some naturalists it is thought that the hens select as mates the birds which build the best bowers and shelters; for note that the males alone are concerned in the building of these remarkable structures. The bowers vary architecturally according to the species, but, in general, they take the form of short tunnels. At the entrance the males place all the bright-coloured objects they can collect, bits of ribbon, shells, old bleached bones, etc.

When the male is courting, he takes some gaudy flower in his beak, or a shell maybe, and chases the object of his affections through and around the bower, the while he gives vent to a strange whistling note and droops his wings alternately. One species of bower-bird decorates the entrance to his shelter in lavish manner. First of all he lays down a carpet of the greenest moss he can find, and on this carpet, which he keeps scrupulously clear of rubbish, he arranges flowers, fruits and brightly coloured fungi. As these transient decorations wither, they are thrown away and replaced by fresh material.

Yet another species has other architectural ideas and, instead of the usual tunnel, he constructs a giant pyramid, often six feet high, and decorates its walls with flowers. On the other hand, there are bower-birds which build no bowers, merely clearing a patch of ground on which the better to display their good looks before the females. In any event, the bowers are nothing to do with the nests,

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they are simply built by the males for the delectation of the opposite sex.

Every male bird by his colouring, his antics, his vocal powers or his fighting capacity does his utmost to appear in favourable light before the females. From the drab sparrow to the gorgeous bird of paradise, there is no exception. Having won the affections of the trustful hen, a consummation which is not always easily brought about, he frequently lapses from the path of virtue and sometimes becomes a veritable tyrant.

Courtship amongst insects is rare. Lord Avebury gives an amusing account of the efforts of a springtail to win a bride. He says: "It is very amusing to see these little creatures coquetting together. The male, which is much smaller than the female, runs round her and they butt one another, standing face to face and moving backwards and forwards like two playful lambs. Then the female pretends to run away and the male runs after her. With a queer appearance of anger, he gets in front and stands facing her again; then she turns coyly round, but he, quicker and more active, scuttles round too, and seems to whip her with his antennæ; then for a bit they stand face to face, play with their antennæ and seem to be all in all to one another."

Several species of spiders are adepts at courtship. Mr and Mrs Peckham have described their antics from actual observation in the following words (a male and female were placed together in a box):—"He saw her as she stood perfectly still, twelve inches away; the glance seemed to excite him and he moved towards her; when some four inches from her he stood still, and then began the most remarkable performance that an amorous male could offer to an admiring female. She eyed him eagerly, changing her position from time to time so that he might be always in view. He, raising his whole body on one side by straightening out the legs, and lowering it on the other by folding the first two pairs of legs up and under,

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leans so far over as to be in danger of losing his balance, which he only maintains by sidling rapidly towards the lowered one. The palpus, too, on this side was turned back to correspond to the direction of the legs nearest to it. He moved in a semicircle for about two inches, and then instantly reversed the position of the legs and circled in the opposite direction, gradually approaching nearer and nearer to the female. Now she dashes towards him, while he, raising his first pair of legs, extends them upwards and forwards as if to hold her off, but withal slowly retreats. Again and again he circles from side to side, she gazing towards him in a softer mood, evidently admiring the grace of his antics. This is repeated until we have counted one hundred and eleven circles made by the ardent little male. Now he approaches nearer and nearer, and when almost within reach whirls madly around and around her, she joining and whirling with him in a giddy maze."

Of another species these observers write: "A dozen or more males, and about half as many females, were assembled together within the length of one of the rails. The males were rushing hither and thither, dancing opposite now one female, now another; often two males met each other, when a short passage of arms followed. They waved their first legs, sidled back and forth, and then rushed together and clinched, but quickly separated, neither being hurt, only to run off in search of fairer foes."

Fabre, than whom no keener student of nature ever existed, described the courtship of scorpions, and Warburton, inspired by him, writes the following quaint words: "After some very curious antics, in which the animals stood face to face with raised tails, which they intertwined . . . they always indulged in what Fabre calls a *promenade à deux* hand in hand, so to speak, the male seizing the pincers of the female with his own and walking backwards, while the female followed, usually

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without any reluctance. This promenade occupied an hour or more, during which the animals turned several times. At length, if in the neighbourhood of a suitable stone, the male would dig a hole, without for a moment entirely quitting his hold of the female, and presently both would disappear into the newly formed retreat."

Crabs are not exactly the creatures that one would expect to show any amorous proclivities, yet some of them certainly do so. Colonel Alcock relates the story of the amorous fiddler-crab in the following picturesque manner:—"Landing one afternoon in March upon a cheerful mud-flat of the Godavari sea-face, I was bewildered by the sight of a multitude of small pink objects twinkling in the sun, and always, like will-o'-the-wisps, disappearing as I came near to them, but flashing brightly on ahead as far as the eye could reach.

"It was not until I stayed perfectly quiet that I discovered that these twinkling gems were the brandished nippers of a host of male fiddler-crabs. By long watching I found out that the little creatures were waving their nippers with a purpose—the purpose apparently being to attract the attention of an occasional infrequent female, who, uncertain, coy, and hard to please, might be seen unconcernedly sifting the sand at the mouth of her burrow. If this demure little flirt happened to creep near the burrow of one of the males, then that favoured individual became frantic with excitement, dancing round his domain on tip-toe and waving his great cheery hand as if demented. Then, if another male, burning with jealousy, showed a desire to interfere, the two puny little suitors would make savage back-handed swipes at one another, wielding their cumbrous hands as if they had no weight at all.

"Unfortunately, though I spent many a precious hour on the watch from time to time, I could never see that these combats came to anything; the males seemed always to be in a state of passionate excitement and the females to be always indifferent and unconcerned; and though

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the dismembered chelipeds of vanquished males could often be seen lying on the battle-field, I have never had the satisfaction of beholding a good stand-up fight, fought out to the sweet end, or a female rewarding a successful champion with her heartless person."

CHAPTER XIV

QUEER FRIENDSHIPS

IN the animal world there are very many examples of the most extraordinary friendships ; animals of the most diverse kinds live together, wholly or partially, and usually to their mutual benefit. This friendship or commensalism, as it is called by naturalists, reaches its highest development among the ants. These social insects are surrounded, either designedly or accidentally, by more friends and cadgers than any other insects ; moreover, they have domesticated some of these outsiders. Green-fly, scale insects, tree-hoppers, lantern-flies, jumping plant lice and caterpillars of the well-known " blues " are all kept by ants as man keeps his cattle.

Let us study an ant farm wherein green-fly or aphides are the cattle. These insects make ideal cattle for ants by reason of the fact that they live huddled together at close quarters and are not very active, especially in their wingless stages. The aphides attack practically all plants except ferns ; some live on leaves, some on stems, others on roots. Most of them live on the surfaces of plants, but a few inhabit galls of their own making and therefore are out of reach of the would-be farmers. The habits which render these insects so accessible to ants also expose them to a host of enemies, but of these more anon. Green-flies are one and all armed with sharp pointed beaks or rostrums with which they pierce plant tissues and suck up the juices. These watery juices contain sugar, of which a very small portion is retained by the green-fly and a large portion is voided as excrement.

The dried excrement is known as " honey dew " and, being sweet, is much sought after by the ant, or even by

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man—the manna of the Bible is “honey dew” of an aphid which feeds on the tamarisk. The amount of “honey dew” excreted by a healthy aphid is astonishing; the maple aphid has been observed to void forty-eight drops in an hour. “A source of nutriment at once so rich and so inexhaustible could hardly remain unnoticed and unexploited by the ants in their interminable search for liquid food.”

The behaviour of ants when they fall in with a colony of green-fly is remarkable. Before the ants arrive on the scene the aphides may be observed to discharge their “honey dew” to a considerable distance. In the presence of the ants, the droplets are simply allowed to escape and not forcibly expelled. The ants wander about among the aphides, pausing here and there, and frequently caressing their friends on either side of their bodies with their antennæ. This gentle stroking causes the aphides to void “honey dew,” which is at once imbibed by the ants. The operation is repeated again and again, usually with success, but sometimes unsuccessfully. In the latter event, the ant wastes no time with the aphid, but passes to the next “cow” in the hope that it will prove more fruitful.

Sometimes the ants are so numerous and so persistent in their attentions that the aphides literally become dried up, then the only available course open to the ants is to wait till their “cattle” have pumped up a fresh supply, or to go on to a new colony. One thing is certain, an aphid which contains “honey dew” never fails to give it up to a soliciting ant, in fact the long-suffering insects will often yield drop after drop in succession to one ant after another.

In connection with the well-authenticated friendship of ants for aphides, a very ingenious though absolutely inaccurate story has gone the rounds. On the backs of many, though not of all, aphides there are two little projections or tubercles. From these, it has been stated,

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the ants draw the sugary liquid of which they are so fond. Pictures have been painted of the ants imbibing droplets from the tips of the tubercles. The fact remains, however, that the tubercles are organs of defence, as the following little experiment will show. If the grubs of the lacewing fly are introduced to a colony of aphides and carefully watched, it will be observed that the active grubs at once proceed to attack their fellow-insects, which, in fact, form their natural food. Aphis after aphis will be seized in the grub's powerful jaws and sucked dry.

Occasionally, if we watch carefully, we shall observe that there is a hitch in the usual proceedings; the aphis, so to speak, gets in the first blow and discharges a sticky, wax-like substance from its tubercles into the face of its enemy. This substance hardens at once and forms a veritable mask over the face of the aggressive grub, to such an extent that it is forced to abandon its hunt till it has cleaned itself, an operation which takes some considerable time and permits of the aphis making good its escape. Here we may notice a very interesting and striking fact—the aphides which habitually live in company with ants have either no tubercles or feebly developed ones; those which are not visited by ants have these organs well developed. Why? The ants afford protection to the green-fly from their enemies so that it is unnecessary for them to be provided with organs of defence.

So far we have only mentioned the visits of ants to stray colonies of aphides, but the relationship of these two kinds of insects is often far more intimate. Some ants actually farm certain aphides. The common aphis of the Indian corn is a good example, so we will relate some of the observed facts concerning this insect. The green-fly eggs are laid in the autumn and are carried by the ants into their underground nests; here they are tended throughout the winter; they are moved about with great care in order that they may be kept in suitable climatic conditions.

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In the spring, when the young aphides hatch, they are transferred by the ants to the roots of various wild grasses. In fine weather the "cattle" are taken from their roots and placed to browse on the grasses above ground, but in cold weather and at nights they are taken back to the ants' nests. No mother could care for her young more tenderly than the ants tend their adopted offspring. As the season advances and the Indian corn begins to grow, the ants transfer their charges from the wild grasses to the roots of the cereal.

Now the first-born aphides are all females and they soon begin to lay eggs; these, in turn, are assiduously tended by the ants, till at length a large colony arises and the ants are kept busy transferring their charges to the most favourable feeding-grounds, always on the corn roots. All the while the Indian corn plants survive and afford nourishment for the aphides the latter are entirely wingless. When, however, the roots become tough and woody or shrivel up, a generation of winged and wingless forms arises.

These winged forms are females whose one desire is to escape to more favourable feeding-grounds. The ants, however, not to be balked of their "cattle," clip off the wings of these individuals, so that escape is impossible, and their progeny are, therefore, saved to the ant community. The aphid is thus wholly dependent upon the ant for its existence and, in return, yields a copious supply of "honey dew" to its insect masters. That the aphides bear no malice to their masters is shown in many ways; except for the winged forms, they never attempt to escape from captivity nor do they ever use their tubercles against the ants; moreover, they give off honey dew more gently and more freely when attended by ants than when living alone. Ants, on the other hand, never kill or injure their charges as they frequently do other defenceless insects; in fact, they protect them. They place them in the most favourable feeding-places, build chambers round them,



AN INSECT FREE-BOOTER, AND AN INSECT BEGGAR.

The extraordinary looking insect shown towards the top is the lepismid, or fleet-foot, who lives by stealing food from ants when they are in the act of passing it from one to the other. The atemeles beetle shown below is begging food, which will not be refused, from the ant in front of him.

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scrape earth from the roots so that they may obtain their food more easily and attend assiduously to their eggs and young.

A very similar relationship also exists between certain ants and some scale insects which also give off "honey dew." Frequently the ants will transfer their insect "cattle" to favourable feeding-grounds on well-liked trees or shrubs and build around them a shed of woody debris as a protection against enemies and inclement weather. Adult "blue" butterflies of the species whose caterpillars are farmed by ants appear to understand the situation to a nicety, for they are very particular as to where they lay their eggs. "If the right plant has no ants, or the ants on that plant are not the right species, the butterfly will lay no eggs on that plant." Some caterpillars will certainly not live without the ants and many are extremely uncomfortable when brought up away from their masters.

One of these peculiar butterflies, a native of India and Australia, spends its whole life in ants' nests and is very peculiarly built to suit it for the life. The caterpillar from which the ants derive their "honey dew" has a horny skin instead of the soft coat which clothes most caterpillars. The skin also forms the covering of the chrysalis, as in flies, a most peculiar happening amongst butterflies but useful as a protection in the absolutely defenceless chrysalis stage. But most strange of all is the butterfly itself, which would probably be attacked by the ants were it an ordinary butterfly, for they are no respectors of persons. It is cunningly contrived with a multitude of loose scales. When the ants, which do not seem to connect the butterfly with the caterpillars from which they have obtained their "honey dew," make an attack on the insect, their legs and antennæ become so hopelessly encumbered by the loose scales that they are powerless to do further mischief. An assault on the butterfly results in a tarring and feathering for the aggressors. In short, all ant farms are mutually beneficial to insect farmers and

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farmed: the former obtain excellent fare in return for the protection they afford to their herds.

There are many other ant friendships not of the ants' seeking, and this is hardly surprising. The warmth of ants' nests, the protection they afford, the odd scraps of food they provide, coupled with the very curious habit possessed by all ants of nursing the young of insects other than their own, all tend to render the ant dwelling decidedly attractive.

One of the most peculiar of these little friends is a small, brownish American beetle, which runs about the nests of its ant acquaintances with surprising agility. From time to time it pauses on its way, raises the front part of its body in the air and awaits the coming of an ant. When a passing ant happens to touch it, the beetle waves his fore-legs in the air to attract attention. The ant is not slow to observe the signal; it stops and licks the beetle's head effusively, till at length it regurgitates a drop of liquid food which the beetle eagerly devours. This proceeding may be repeated again and again, but after each feed the ant carefully licks the beetle's face clean; in fact, she seems so fascinated with her pet that she cannot feed and fondle it enough. Sometimes the beetle is not so fortunate, for when sitting up and begging for food he may be inadvertently knocked over in the general hurry and scramble of the ants' nest. At such times, after lying for a little while on his back with legs sprawling in the air, he will suddenly right himself and scamper off or remain and strike his favourite attitude once more.

Another little insect frequenting ants' nests and a close relative of the common "silver fish" of this country is not quite so honest as the beetle which has learned to beg; in fact, he is a barefaced robber and a nuisance to the ants, for they often try to catch him while he is thieving, but he is usually too alert to be caught. Now it is a common ant habit to pass liquid food from mouth to mouth and this is especially the case when the workers have returned

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from a foraging expedition. The insect robber watches his opportunity and when he sees two ants mouth to mouth and about to pass the luscious liquid, he springs up and gulps it up in mid-air and there remains a disappointed ant and a satisfied ant guest.

The friendship of a little fly for a favourite ant is so near to parasitism that we are not sure if it should find a place in this chapter ; at any rate, the fly is so considerate of its host that it does little harm, so we will not class it among the evil-working parasites. The fly lays its eggs in the ants' nest and its grubs on hatching immediately affix themselves to an ant grub by means of a sucker-like tail. Now the worker ants, as is their wont, pay great attention to their grubs and feed them constantly with pieces of insects.

A meal for the ant grub means a meal for the fly larva, for the latter always partakes of a portion of the fare provided. When the ant grub spins its cocoon, the little visitor goes with it into hiding, but it takes the precaution of moving to the tail end of its temporary shelter, lest, later on, when the ant is eating its way out to freedom, it should receive a bite by mistake. The ant comes from the cocoon first and the empty case, or so the ants think, is removed to a refuse heap outside the nest and the fly emerges at a later date. Who can fail to admire the wonderful workings of Nature in this and in hosts of similar cases? The little fly grub is really a parasite, there is no use in denying the fact, but it does no harm to its hosts ; they clean it as carefully as they clean their own larvæ and, happy to relate, the ants which come from the cocoons which they have shared with their guests are as healthy and vigorous as their fellows which have not been so encumbered.

The period in the hermit crab's life when he has grown too big for his purloined home and must needs seek a larger shell is always fraught with anxiety. To watch the crab changing from his old home to the new one is most

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entertaining. He takes every precaution that his new dwelling is fit for habitation and, having satisfied himself on that score, he transfers his ungainly body from one shell to another with a celerity which is astonishing. When the new home proves unsuitable, back he dashes to his late abode, which, by the way, never leaves his grasp till he is satisfied that he will want it no longer.

Some hermit crabs, however, more fortunate than their fellows, are saved all worries of house moving and that by the good offices of a friendly sponge. The young sponge takes up its abode on the whelk or other shell which is serving as a shelter for a hermit crab. Rapid growth takes place and it is not long before the shell, with the exception of the mouth, is completely enveloped by the sponge.

Now it is a remarkable fact that, whatever the size attained by the sponge, and it is often considerable, the opening of the shell is never closed, but a tubular passage is always in front of it. It frequently happens that sponges and their kind, when they settle on a shell in this manner, eat away its substance, or at least cause it to become so rotten that the water soon completes the work of destruction; the sponge we are describing never damages the hermit crab's shell.

As may be imagined, there comes a day when the crab is too large for his home, so he simply walks a little way down the tube of sponge which has been built up before his door and, by so doing, avoids the trials and dangers of changing his shell; for, being a soft-bodied creature, the danger when uncovered by a shell, as he is for a moment or two when he is engaged in moving, is very great. Enemies await this change and catch him moving if they are able. The sponge then, apparently a hindrance to the movements of the crab, in reality provides him with a house which grows continuously; a house, moreover, which affords him ample protection. The continual transport from place to place which the sponge

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enjoys by reason of its association with the hermit crab is beneficial and may account for its rapid growth.

In tropical Australia there are two kinds of very large sea-anemones which are on friendly terms, the one with a brilliantly coloured fish, the other with a prawn. To make our story intelligible, let us explain that the sea-anemone resembles an empty sack standing with its open end uppermost. This open end forms the mouth and is fringed with tentacles. The tentacles are waved about in the water in which the anemone dwells and when they come in contact with any creature suitable for food it is stung and passed into the interior of the sack, which is the anemone's stomach; then the prey is digested and the indigestible parts are thrown out later by the same way as they entered. Well, curiously enough, the friendly fish and prawn swim about amongst the tentacles of their respective sea-anemones, who, on their part, never attempt to sting their friends. When danger threatens, the fish or the prawn, as the case may be, seeks safety in the anemone's stomach, once more without suffering any harm. Now these cases of friendship in nature are never one-sided, but the case we are describing gave naturalists a difficult puzzle to solve.

The association seems so odd, so unnatural, nevertheless a theory has been propounded to account for it and at least it possesses the merit of being plausible. Both fish and prawn are brilliantly coloured, as we have remarked; being so, they are likely to attract fishes of larger size on the hunt for prey. When they are attacked, escape for them is easy within the body of the anemone, as their would-be attackers are at once paralysed by the anemone's stings and passed into its stomach to form a tasty meal.

The association of a certain fish with an American jelly-fish is not quite so happy. The fish shelters beneath the umbrella-like body of the jelly-fish and probably brings much provender to its protector, just as in the case we have mentioned above. Sometimes, however, whether for

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amusement or necessity we cannot say, the fish bites a piece from the tentacles or body of the jelly-fish and, as is only fitting, the jelly-fish occasionally captures and devours the fish it has protected. Why such a precarious companionship should exist it is by no means easy to guess.

Friendship between a crab and a pond mussel seems to savour of the improbable, yet such a case is quite common. Now a crab is usually a hard-shelled creature, armed with many sharp angles and often spines which, it would appear, must certainly endamage the flesh of the mussel, seeing that it is as soft as that of the familiar oyster. This particular crab, however, is especially well adapted for the life he has chosen; all his sharp angles have been dispensed with and he is as smooth and round as a pea, in fact he is called the pea-crab.

The active little creature spends all his time within easy reach of his protector the mussel; at the slightest sign of danger he dashes back into the mussel shell and hides himself among the sheltering fold of the shell-fish, at the same time the valves are closed. In this case the partnership is mutually beneficial: the crab warns the mussel of impending danger and, in return, is protected by the shell of the bivalve.

Partnerships of a similar nature, where one partner receives certain benefits in return for giving warning of danger, are quite common. The oxpecker or rhinoceros bird is never so happy as when perched on the back of some friendly rhinoceros or other big game, picking, here and there, a dainty morsel in the shape of some tasty tick. At the slightest hint of danger the bird flies away and the rhino prepares to beat a hasty retreat or to attack, as the case may be. Those much-persecuted birds, the egrets, perform similar offices for elephants. The "beef-eater" birds, which find their sustenance in warbles on the backs of buffalo, and the Egyptian split-winged and black-headed plovers, friends of the crocodile, from

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whose teeth and gums they remove leeches, both give warning in return for food. The friendship of bird for bird is uncommon, but a striking case is that of the rosy bee-eater and the crested bustard, described by Mr Arthur Neumann in the following words:—"The bee-eater habitually rides about on the back of the large crested bustard or 'pauw' which is common about the north-east extremity of Bassu. It sits far back on the rump of its mount, as a boy rides a donkey. The 'pauw' does not seem to resent this liberty, but stalks majestically along, while its brilliantly clad little jockey keeps a look-out, sitting sideways, and now and again flies up after an insect it has espied, returning again after the chase to 'its camel,' as Juma (a native servant) not inaptly called it. I have also noticed this pretty little bird sitting on the backs of goats, sheep and antelopes, but the 'pauw' seems its favourite steed. I imagine it gets more flights in this way at game put up by its bearer, which also affords it a point of vantage whence to sight and pursue its prey in a country where suitable sticks to perch on are few."

Of strange bedfellows in the bird world there are many. Small and defenceless birds will often nest on the outer portions of the enormous nests of the osprey. The burrowing owl shares a burrow with the prairie dog; certain New Zealand petrels dwell and nest in the same burrows as the formidable teratera lizard. But let us pass to other examples in the animal world.

That any creature should make a friend of the cruel and voracious shark is almost unbelievable, yet the pilot-fish does so. Few creatures will, of their own free will, approach a shark, so the pilot-fish lives its life free from danger, and in return it removes certain parasites from the shark's skin.

Our last example can hardly be termed a friendship, we fear. It concerns a night-flying moth and a plant. That the insect might have friendly feelings towards the plant

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might be feasible were it allowed that insects are endowed with feelings; but, on the other hand, the plant certainly cannot feel any emotion whatever. The case of the moth and the yucca plant, often called Adam's needle, is so extraordinary, and plant and moth are so perfectly dependent on one another, that we make no excuse for introducing them here. So interdependent are they that without the moth the plant would never form seeds, whilst the larvæ of the moth can only exist upon the seeds of this one kind of plant; both moth and plant are constructed for their mutual aid.

On the head of the moth there is a unique structure, shaped like a sickle and used for the express purpose of scraping up pollen from the yucca flower. Having gathered a ball of pollen from the first yucca she visits, the female moth flies to another flower of the same kind and deposits her eggs amongst the unfertilised seeds. Having done so, she deposits the pollen ball on the stigma of the same flower, thereby ensuring that the seeds will mature, and a very necessary operation this is for both parties.

Unless the seeds are fertilised the yucca cannot reproduce its kind—there is nothing very wonderful in that, half the plants the world over depend on insects for their fertilisation, though, to be sure, the pollen is not usually placed upon the stigma deliberately as in this case. The fertilisation of the seed is equally important to the moth, for upon the fertilised seeds the young larvæ feed. Fortunately each flower forms about two hundred seeds, and luckily, too, the larvæ develop quickly, only eating about twenty seeds before turning into chrysalids, so that both plant and insect are able to survive.

“The whole proceeding is of great interest, showing as it does the blind and instinctive nature of the organisms' actions, and giving us an example of two species absolutely dependent on each other for their continued existence. If the moth had not the structure to form the pollen ball,

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and the instinct to put it on the stigma, the ovules would not be fertilised, and her offspring would have no food ; and if the plant were not prepared to sacrifice some ten per cent. of its brood, the rest would never develop at all."

CHAPTER XV

MIGRATION

AT times, mainly at certain seasons of the year, a strange restlessness overcomes animals and they change their quarters for some more congenial spot. This wandering from one part of the earth to another is termed migration. Insects, birds, mammals and even fishes are all victims of this craving for new fields, but the habit reaches its zenith amongst the birds. It is hard to define exactly when migration begins and when it ends. The chicken which leaves its home farm and joins its neighbours of the next poultry yard, migrates; the fox which, maybe through too persistent attention on the part of the local hunt, seeks another earth, migrates; but for our purpose migration implies a regular organised movement from one country to another, or at least from one end of a country to another.

Amongst insects, migration does not appear to be a fixed habit, except in a few cases. The wholesale wanderings of the processionary moth larvæ cannot, strictly speaking, be termed migration. In South Europe we have seen hordes of cockchafers descend upon a district, destroying the vegetation far and wide, and there are well-authenticated cases of migration amongst certain species of butterflies. But all these are not regular periodical movements; they are merely occasional wanderings and, as such, do not come under our definition of migration. Of all insects there are none with migratory habits so highly developed as the locusts; one species, in fact, is called the migratory locust. These migrations have a great influence on the inhabitants.

The locusts appear in vast swarms, and eat up every scrap of vegetation, till nothing green remains in the land for

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man and his herds. So great are these swarms that it difficult to imagine their vastness unless they have been seen. Millions upon millions of these six-legged robbers darken the sky as they move from place to place. In the autumn of 1889 an enormous flight took place over the Red Sea ; it extended for 2000 miles and it was estimated to weigh no less than 42,850 millions of tons. On the following day another and still larger swarm passed in the same direction. In Cyprus alone, during the year 1881, 1,600,000,000 locust egg-cases were collected and destroyed. Seeing that each case contained several eggs, it is clear that this destruction saved the island from a vast horde of locusts. By the end of the season more than 1300 tons of egg-cases had been destroyed, but all this energy on the part of the authorities did not prevent 5,076,000,000 egg-cases from being deposited on the island in 1883.

A natural concomitant of locust swarms is disease, fostered, no doubt, by the decay of millions of the dead bodies of the locusts. These locust migrations take place periodically and at considerable intervals. The instinct to migrate seems to become acute when the swarm has increased to unwieldy proportions and the ranks are thinned considerably by hosts of parasites and also by inclement weather. Should there be a very unfavourable season, the eggs do not hatch from the egg-cases, they simply stay below ground till better times come.

In locust migration wind is a very important factor and many trial flights are made to test its direction before the main swarm sets out to migrate. As a rule, the insects travel with the wind behind them, and are carried by it without any exertion ; should its direction change, they simply alight, wherever they may be, and await a more favourable opportunity for flight. The immature locusts also migrate, and they do so not by flight but by a series of short hops. The incentive to migration in their case is lack of food and a desire for change.

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To the birds we must turn if we would study migration in its highest form. "The migratory movements of birds are interesting in the extreme. Their arrival is the harbinger of spring; their departure the unfailing sign of winter's advent. But of higher interest still are all the causes and influences which prompt and govern these various migratory movements. We see the woods all radiant with opening leaf and fragrant bloom suddenly become tenanted with these little wanderers from sunny southern lands—delicate little creatures many of them, whose bodies would scarcely fill a good-sized thimble, yet we know these frail little feathered travellers have covered the land and sea for many thousands of miles—they are fresh from the palm-trees and glorious wealth of tropical verdure far away in the soft, lovely south. The terrors and perils of the long journey are soon forgotten—like dreams they pass away, and songs of sweetest cadence pour joyously from their little throats. In autumn's balmy days we see these migrants preparing for their long journey. All is eager excitement to be gone. The browning leaves and mournful winds of autumn, the first white frost and cool nights, sternly bid these little travellers depart. As we watch them flitting restlessly about from twig to twig, or congregating in merry flocks on buildings and telegraph wires, we think of their early departure with regret and from the bottom of our hearts we wish them a speedy and a safe return."

The seasonal wanderings of birds have occupied the attention of many eminent naturalists, yet it is strange how little we really know of the subject, astonishing how much there is still to learn. Migration in birds is chiefly concerned with the necessity of finding suitable breeding-places and suitable breeding-places only exist where the food supply is abundant, so that the food question is really at the bottom of migration. Needless to say, the extent of migration varies enormously in different species.

The grouse nests on the moors but seeks the valleys

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during winter and, in the case of this typically British bird, a change of habitat from one "fell" to another marks the limit of its wanderings. At the other extreme, or near it, is the knot, which breeds in Greenland and migrates in the summer to Demerara-land; or the Arctic tern, which breeds as far north as any bird, but in summer travels 22,000 miles to the far south. It has been said that the farther north a bird goes in summer the farther south it travels in winter. We are prone to imagine that "migrants are merely those birds which come to us, like the swallow and cuckoo, in the spring, and those, like the field-fare and brambling, which visit us in winter but are not with us in summer."

Migration is far more complex than this; in fact, considered from the point of view of their journeys or their wanderings, birds have been divided into six groups. (1) Permanent residents in the country, such as the grouse, dipper, tits, robins, etc., but even these migrate to a small extent. (2) Summer residents which nest in this country, cuckoos, swallows, swifts, etc. (3) Winter residents which nest north or east of Britain and arrive in autumn, as field-fares, jacksnipe, bramblings, etc. (4) Spring and autumn migrants, which merely rest here on their journeys north and south, dunlins and curlews. (5) Irregular migrants, such as the sand-grouse. (6) Wanderers whose appearance is purely accidental.

As far as birds of the Northern Hemisphere are concerned, they usually breed in the most northerly limits of their migration and winter in the most southerly, but of course the cold districts are always visited at their warmest period of the year. It has been said that birds never seek fresh nesting-places and thus extend their range, but "within the last few years, for instance, the turtle-dove and the tufted duck have begun to nest regularly in many parts of England of which they were entirely unknown twenty or thirty years ago. The starling also has spread and in some parts is spreading still."

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A little thought will show that birds, in the main, travel north in their search for nesting-places and south in their search for food, but it is interesting to note too that migration usually begins some time before the food supply fails. Swifts leave us in July and August, when insect life is at its height. It is probably not cold, as some assert, but the intuition that their food supply will soon fail that drives our migrants south in winter. During the breeding season, family cares compel migrants to limit themselves to a definite district; but in their winter haunts, free from all cares, many of these migrants are nomadic, as witness the wanderings of flocks of redwings and field-fares over this country in winter. Then, again, certain birds, the snow bunting and shore lark to wit, have been termed gipsy migrants, for the reason that they wander southward only so far as frost and snow compel them—they are always trying to go north.

Observation, too, has shown that many migrants have certain favoured spots in this country which they visit from year to year during their pilgrimage; thus certain migratory sandpipers regularly visit the lower reaches of the Mersey every autumn. This "regularity of appearance suggests habit and memory" rather than a haphazard discovery of a favourable food supply.

It has been asserted that family instincts are at the root of bird migration. That this may have been so originally is possible, but incapable of proof, and there are other theories which we shall mention later. Were family affairs the crux of the matter, there would not be such a large proportion of immature migrants. Moreover, these inexperienced birds are often the first to make the long journey from their southern feeding-grounds. With such vast hordes of birds arriving at and departing from our shores, and even passing over our land without a halt, how is it that the ordinary man sees so little of the game?

True, we have all beheld the swallows collecting on roofs and telegraph wires, preparatory to their autumn

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flight, but of migration in general we see very little, for the reason that the birds as a rule fly at high altitudes, ranging from 1200 to 5000 feet. In autumn the migration is most marked, for in spring the birds arrive in little parties, but in autumn they travel in enormous flocks. Some fly in pairs, some in sexes, the males arriving first and leaving last. Sometimes the young birds migrate first. Some travel only by day ; others, again, are night flyers. However they go, they always arrive and depart well to time.

The direction of the wind appears to have little effect on migration, but its force may render migration impossible. They travel, for the most part, in the upper layers of the air, for "birds are warmer blooded than ourselves or other mammalia, and are capable of sustaining life in rarefied atmospheres when these could not. By a simple mechanical ascent, they can reach, within a league or two, regions and conditions quite beyond human knowledge ; where, selecting favouring air-strata, they may be able to rest without exertion ; or find meteorological or atmospheric forces that mitigate or abolish the labours of ordinary flight, or possibly assist their progress."

The perils which envelop birds during migration are enormous : the weaklings perish of fatigue and hunger ; adverse winds drive them from land to sea. Predatory birds, hawks and the like, accompany them, taking toll *en route*, and predatory man awaits the tired wanderers with gun and net. On foggy nights countless numbers perish at the lighthouses, as the remarks of an observer at the Skerryvore show, for he likens the birds around the lighthouse to a heavy fall of snow. "Thousands were flitting about ; hundreds were striking against the dome and windows ; hundreds were sitting dazed and stupid on the trimming paths ; and scores falling to the rocks below, some instantaneously killed, others seriously injured, falling helplessly into the sea. . . . Sometimes we use the terms hundreds and thousands without thinking seriously

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what these figures mean, but on this occasion when I say thousands were killed I do not exaggerate in the slightest."

Some of the early theories concerning bird migration are vastly humorous, in the light of our present-day knowledge, scanty though it be. That birds did migrate was known in Biblical times; that they migrated to the moon was a surmise of a later date. A theory that was widespread, still later, assumed that birds must be classed among the hibernating animals. Swallows had been seen in reed-beds, preparatory to their autumn flight; the day arrived when the swallows had disappeared—they must have hibernated in the water! Often a sudden fall of temperature at this season would result in the death or stupor of a number of birds and their discovery in this state was looked upon as confirmation of the hibernation theory. That the stronger birds carried the weaker on their backs during migration was another common fallacy.

Migration is merely a habit and one that has been slowly acquired with the expenditure of much labour and many failures. For thousands of years these journeys have been undertaken, till now, as we have said, it is a deeply rooted habit. This habit probably originated owing to changes on the face of the earth. Once the polar regions were fertile lands with a large resident bird population. Then when the earth changed her position and an ice-cap was formed, lack of food drove the birds southward. This all occurred during a very long period, sufficiently long to implant the migratory habit in birds. When the glacial epoch passed and the snows began to melt and the ice to drift back, the birds returned farther and farther north. Age after age the journey became longer, till it attained the dimensions of the present day. Water birds travel farther than land birds, for the latter are practically confined to the limits of forest growth. It is of interest to note that many migrants follow the direction of ancient coast-lines, which are now buried

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beneath the sea ; this may account for the many birds which cross the North Sea to this country and then pass due south across the Channel.

Migration amongst fishes is of quite common occurrence, though the subject, in general, is of too abstruse a character to deal with in these pages. A certain South American fish, equally at home on land or in water, travels rapidly overland by violently lashing its tail, supporting itself the while on its breast fins. In this manner it passes from one waterway to another. Occasionally whole nights are occupied in the journey. Usually these fishes travel singly or a few at a time ; sometimes, however, they migrate in large bands.

Well-authenticated cases of migration occur amongst salmon and eels, therefore we will confine our remarks to the wanderings of these two common fishes. The life history of the salmon is interesting in the extreme ; part of its existence is spent in fresh water, part in the sea. During the summer and autumn there is a regular migration from the sea to the rivers. Spawning takes place in fresh water. There the young grow into parr and smolt before travelling back to the sea, where they become grilse and salmon before returning to fresh water. After the salmon have travelled up-stream to spawn, a journey fraught with dangers and difficulties, which the fish use every effort to surmount, they pair off and seek some gravel-bed in a shallow part of the stream ; then by violent lashing of their tails they form a hollow, in which the eggs are laid and fertilised, and, by further tail-lashings, are covered with gravel. The usual time for this family event to take place is November and December, but spawning may go on from September to January. In addition to this so-called spawning migration, a general seasonal migration of salmon takes place every year. By marking the fish in their young stages some interesting experiments have been carried out, which have proved that the spawning salmon usually return to the

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same river in which they were brought up, despite the fact that they wander for considerable distances from the mouth of their home river during their life at sea.

Interesting as is the migration of salmon, that of the common eel is far more so, and it is only in comparatively recent years that it has been fully understood. In fact, not so very long ago young eels were considered as quite a distinct and peculiar kind of fish and were not associated with eels at all. There has always been something akin to mystery surrounding the life history of the eel. Aristotle gave it as his opinion that eels were formed from mud. A belief which still holds sway in some parts of the country was once widespread—namely, that horse-hair falling into the water would grow into eels.

For many years all that was known of this very common fish was that young eels or elvers migrated from the sea to the rivers in spring, and that silver eels, as the mature fish are called, migrated seawards in autumn. It has now been firmly established that eels spawn in mid-ocean; from their eggs arise curious leaf-like little fish, so frail and transparent that only their eyes are visible as they swim in the water and so unlike their parents that they were called *Leptocephali*. These tiny creatures are quite unable to battle with the waves, so they simply drift upon the Gulf Stream till they are carried towards the coasts of the Atlantic. When they drift to shallower water they change from *Leptocephali* to elvers.

At the mouths of the rivers they dwell for a time and collect in vast crowds; when their numbers are sufficient the vast army migrates from the sea to the upper reaches of the rivers, travelling mostly at night, unless there be a full moon, when the migration is hindered, for light seems distasteful to the little voyagers. In fact, the eel is of somewhat nocturnal habits; even the adults feed, for the most part, by night. Several years are spent in the rivers before the eels are ready to migrate to the sea for spawning. When that time arrives they change in

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appearance considerably : their backs become darker, their under sides lighter and their eyes larger. The silver eels, as they are now called, like the elvers, migrate only by night, and on moonless nights at that ; occasionally they travel massed together in balls. After spawning the eels die, so that, unlike the salmon, they migrate only once during their adult lives. Frequently eels have been observed travelling overland from place to place, wriggling through the herbage, after the manner of a snake. These land journeys can hardly be termed migration.

Amongst quadrupeds migration is by no means common. The reindeer is a migrant. In Spitzbergen, where there are large herds of these animals, the reindeer seek the valleys during the short Arctic summer, but in autumn they turn their steps back to the sea coast, where they feed mainly upon seaweed. It is said that a female always leads the migratory herds. In Arctic America, where the reindeer is known as the caribou, there is a regular southward migration in winter, but in summer the herds return to their northern uplands.

The South African springbok is also an occasional migrant. When the absence of rain causes its almost desert home to become absolutely barren, it migrates eastwards to more fertile regions. Travellers have described enormous herds of these migratory antelopes moving in a solid mass of over half-a-mile in width and taking over two hours to pass a given point. They have even related that the herds were of such enormous size that a lion, attempting to prey upon one of their number, became so surrounded by the migrants that escape was impossible and he was forced to march along with them.

Thirst is the compelling force in the case of the springboks, and not long ago thousands upon thousands migrated to the sea, drank of the salt water and died in countless numbers ; for miles upon miles the shores of the Indian Ocean were strewn with their dead and decaying bodies.

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Of all quadrupeds, the most notorious migrant is the lemming, a small rat-like creature, inhabiting the mountainous regions of Northern Europe. At long intervals these destructive little creatures migrate from their mountain fastnesses literally in millions. Lack of food or the foreboding of severe weather may account for their wanderings; but, whatever the cause, they lay waste the land far and wide as they go. Travelling chiefly by night or in early morning, they brook no obstacles. They swim rivers and lakes. They are accompanied by a crowd of camp-followers in the shape of predaceous animals and birds, but on and on the horde advances, till finally the sea and the sea alone forces a halt.

CHAPTER XVI

HUNTERS AND HUNTED

IN the world of nature there is a constant struggle for existence every minute of the day ; every day in the year hunters and hunted are in conflict with one another, the one seeking the wherewithal to live, the other striving to avoid destruction. Nature has been described as cruel ; be that as it may, the weapons with which certain animals are provided, their ingenuity in using them and their almost saturnine cunning, render the lives of their adversaries one long period of watchfulness. The domestic cat and dog may well be taken as our examples of typical predaceous animals—that is to say, animals which prey upon others. Their habits and their beautiful adaptations for a hunting existence are easily observed.

In the cat the sense of hearing is marvellously developed ; its ears are in constant motion, that it may detect the slightest sound, and noises which are quite inaudible to us are plainly heard by the cat. Combined with its sharp hearing, its sight is excellent ; moreover, its eyes are readily adapted to changes in the intensity of the light—in sunlight the pupils are mere slits, by night they are large and round. Despite their keen sight, cats cannot see at night, as is popularly supposed ; after dark they rely on their sense of touch, another highly developed faculty. Every hair on the cat's body is exceedingly sensitive to touch, that is why this animal has such a deep-rooted dislike of having its fur rubbed the wrong way. It is, however, in the whiskers and eyelashes that this sense is most highly developed. Its well-padded feet, covered with short hair, enable it to approach its prey without noise ; its lissom body renders possible the use of its needle-

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pointed claws in capturing and killing the most agile victim; though the cat, in common with others of its kind, only slaughters its unfortunate victim after playing with it for some time.

Dogs have been domesticated by man for such varied purposes and for so long a time that it is by no means easy to find an example which conforms to the scientist's idea of the typical dog. In some cases fleetness of foot has been developed at the expense of other qualities; in others the sense of smell is the most important, from man's point of view. However, what we may term the typical dog possesses a keen sense of smell, which serves it in good stead in hunting its prey, though the greyhound, be it noted, relies upon its keen sight rather than upon its nose when pursuing its prey. The nostrils, in health, are always moist—an additional aid in scenting a victim, for a dry nose means a lessened sense of smell.

Though inferior to the cat in hearing, still its powers in this respect are far more highly developed than in human beings. Fleet of foot, it possesses claws certainly, but they are not sharply pointed and never used in capturing prey. A noteworthy fact concerning the dog is that, however heated it may become in the chase, it never perspires in the ordinary way; it breathes, however, some three hundred times per minute in place of the usual thirty, and in so doing removes surplus moisture from the lungs. A panting dog, therefore, is not necessarily exhausted, but simply one that is removing waste products from his system in his own especial way, instead of by perspiration, as with most other animals.

Hearing, sight and touch, then, are the main adjuncts to successful forays on the part of the cat, and hearing, sight and scent on the part of the dog. Having thus disposed of the peculiarities of two of our commonest animals, we are free to examine the methods by which some of the others with which we may not be so well acquainted obtain their food. It is only right to mention

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that teeth are every whit as important as claws and scent and hearing, but a discussion on the dental armament of beasts in general would lead us beyond the depths to which it is expedient to go in our pages.

All the wild members of the cat family rely on the same faculties as their domestic relative in their hunt for prey, and they are aided in their work by their wonderful colouring, which renders them wellnigh impossible to detect in their native haunts. The tawny coat of the lion harmonises beautifully with the desert sand he loves so well; the very brilliantly attired tiger is practically invisible as he lurks amid the vegetation of the jungle; the leopard and jaguar are unconscious mimics of the sun-flecked ground which carpets the tropical forests which they haunt; the lynx in hue matches the boles of the forest trees amongst which he makes his home.

Twixt the cats and dogs we must pause a moment to give some thought to those ill-formed beasts, the hyænas. Their greyish hides dappled with black form the best possible protection for such night prowlers as they are. Their long fore and short hind legs, their clumsy gait betoken a life spent neither in hunting like the dog nor in springing on their prey like the cat. No, the hyæna devours either carrion or attacks some animal already at the point of death and therefore quite unable to defend itself. Pluck is not one of the attributes of the hyænas. Their enormously powerful jaws serve them well in devouring their prey and cracking their bones to splinters, and their extraordinarily keen sense of smell enables them to detect carrion at enormous distances.

Some dogs, of which wolves and jackals may be taken as typical examples, hunt their prey in packs; their sense of smell is acute and their sight hardly less so. But it is not dogs only which hunt in packs. All animals become bolder in the company of their fellows. We can see it in our own country-side: sparrows will often band together in the face of some common enemy, in the shape of an

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owl or a hawk, and harry the unfortunate individual unmercifully.

The South American peccary, a fierce little wild pig, has learned that unity is strength. Singly, the peccary would be no match for some of the larger cats of the South American forests. Hunting in packs, these pigs can even bring fear to the heart of the powerful jaguar. Travellers have related how the peccaries will drive a jaguar to seek safety in some tree. Unable to reach the cat in his temporary sanctuary, the pigs wait below. Hunger and fatigue inevitably compel the jaguar to descend, sooner or later, when he falls a victim to the patient watchers below.

The fox, really a wild dog, is imbued with certain habits which seem almost cat-like. This animal never hunts in company with companions, but sallies forth in the evening to carry out its depredations alone. It yields to few animals in sense of smell and its sight is far keener than is that of its near relatives the dog, wolf and jackal; also, being a night prowler, its pupils are oval like those of the cat. Again, the fox is possessed of short legs, so that it relies rather upon taking its prey unawares than upon running it down. Nevertheless, when circumstances render it necessary, the fox is no mean runner, as many a huntsman can testify.

Animals of the ferret family are all born hunters: stoats, polecats, weasels and martens are one and all blood-thirsty in the extreme. Their senses of sight, hearing and touch are marvellously developed. The pine-marten has been described as the "nimblest and cleverest of all predatory animals which lead an arboreal life. It is a thorough athlete, a true arboreal creature and an accomplished robber, scarcely inferior to the cat. It spends the day calmly reposing in a safe hiding-place, such as the deserted nest of a rook, dove or squirrel. At the approach of night it wakes up for its murderous occupation. With lightning speed it runs up the trunks of the



THREE *VERSUS* ONE

A swordfish and two killers attacked the mighty cachalot in vain. He first bit the swordfish in two, then stretched one killer dead upon the sea with a blow from his tail, and the other fled for his life.

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trees to their swaying tops, and climbs up and down among the branches ; now, again, it may be seen creeping like a cat through the thick grass, inspecting every nook and cranny, sniffing at the holes in the tree trunks, listening, peering now here, now there, in search of some sort of prey or other, be it a sleeping bird, a young hare, a mouse or the like. Now it has caught sight of a squirrel. Unobserved it rapidly ascends the trunk of the tree on the other side of the creature and mounts the branch on which it is sitting. Brushing the branch with its belly, it stealthily creeps up, cautiously placing one foot in front of the other ; suddenly the squirrel catches sight of its pursuer and now a mad chase begins. From branch to branch leaps the frightened creature, hotly pursued by the murderer. With one mighty leap it lands upon a neighbouring tree ; the pursuer follows ; up and down the trunk the race continues. It is only by taking a leap downward, which its pursuer cannot imitate, and rapidly gaining another tree, that the squirrel can hope to escape with its life. Otherwise it is doomed to succumb exhausted and yield up its life under the teeth of the marauder."

The closely related badger and otter are in their respective ways admirably adapted for the capture of the prey so necessary to their existence. The former is a thick-set, clumsy fellow, who can neither climb like the cats, nor, like them, stealthily stalk his prey ; nor can he hunt after the manner of the dogs. His formidable claws, his almost pig-like snout and powerful neck all point to the fact that he is a digger. His prey, for the most part, is captured without the display of any agility. The larvæ of various beetles, earthworms, mice, frogs and lizards make up his principal fare, varied now and again with a nestling or a young rabbit or hare. Many of these creatures live below ground and the badger is not long in unearthing them.

The otter, on the other hand, though an expert

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swimmer, is, on land, nearly as clumsy as his cousin the badger. His prey comprises fish, of which he is said to consume five pounds per day, frogs, water rats and water birds. In their capture he displays his admirable gifts as swimmer, to which may be added his keen sight even under water and a highly developed sense of touch in his long whiskers. The otter is beautifully adapted for an aquatic life. His flexible body, broad, flat head, his webbed feet and flattened tail, which acts as a rudder, all assist his rapid passage through the water. His skin is oily and his coat so thick that the water does not really wet it; his mouth, nostrils and ears can all be closed tightly against the access of water. He is, in short, a living submarine.

Even more perfectly adapted to an aquatic life is the common seal, and this is very natural, for it spends the greater part of its time in water, whereas the otter lives in his burrow for a considerable part of the day at any rate. With his cylindrical, spindle-shaped body the seal is well adapted for rapid passage through the element in which he is so thoroughly at home. Its backwardly directed, short yet powerful fore and hind limbs form excellent oars and rudder. With exceedingly light bones and a thick layer of fat beneath his skin which at once renders the seal lighter than it would otherwise be and protects its vital organs from the cold water, small wonder that the creature is an adept in watermanship; even its ears do not possess the flaps so usual in animals, for these would hinder its progress through the water. Like the cat, the seal hunts by night, therefore it is not surprising to find that he is provided with long whiskers—his usual organs of touch; his sight too is extraordinarily keen. Its sense of smell serves the seal well by giving it information of the approach of enemies.

The bats are of interest in that they apparently possess a sense of which we humans have no experience. All bats are bloodthirsty little creatures; flying by night, they

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spend practically all their waking hours in the pursuit of prey. As the victims are solely members of the insect world, most of them guilty of harming mankind or his crops, the bats can only be considered as useful beasts. As with all animals which capture their prey upon the wing, bats have exceedingly large mouths. Swifts, swallows and nightjars are similarly armed. Their sense of hearing is acute, and in most of them the ear-flaps are enormously developed to form sound-boxes which, so it is said, enable their owners to hear moths and other insects flying abroad. Their sight is poor; in fact they place no reliance upon this sense when in pursuit of their prey.

On the other hand, the bat's sense of touch is developed to such a pitch that it is almost beyond our powers of comprehension. An experiment has been performed in which a bat's eyes were covered with sticking plaster, after which the animal was liberated in a room from the ceiling of which a large number of threads were suspended. This bat flew round and round the room without even so much as touching one of the threads. Prey can also be caught without the use of the eyes, the highly developed sense of touch alone sufficing for the detection of the feeble air vibrations of a flying insect.

Glutton though the bat may be, he is no match for the mole, who daily consumes food equal to the weight of his own body, and should that food not be exactly to his requirements he has been known to eat four times the weight of his own body to compensate for its unsuitability. The prey of this little creature consists of earthworms, cockchafer grubs and the like; all his victims dwell underground, therefore keen sight is useless to the little hunter. His sense of smell, touch—by means of his snout—and hearing are remarkably acute. In autumn the mole lays up a large store of food for the winter in the shape of earthworms—as much as six pounds' weight of these luckless creatures has been found in a mole

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fortress. Now the mole cannot paralyse its prey as can the sand-wasp, yet dead earthworms will soon decay, even in frosty weather. The mole surmounts the difficulty in an ingenious way; he simply bites off a small portion of the head end of each of his victims and, being very tenacious of life, they continue to exist, though their burrowing powers are ended for ever.

Having briefly reviewed some of the notorious hunters of the animal world, we will devote a little space to the consideration of the beasts that are hunted, that we may see how they contrive to avoid the attentions of their enemies, either by flight, by protective or warning colouring, by evil odours or by other means.

The giraffe, so conspicuous a beast in his enclosure at the Zoo, by reason of his size and his yellow, brown-dappled hide, is in his native retreats, beneath some shady tree, preferably an acacia, wellnigh indistinguishable from his surroundings. Now the defences of the giraffe against the attacks of wild beasts consist in rapid flight and powerful kicks. But better than these is the power conferred upon the giraffe, by reason of its long neck, to see its enemies afar. To a lesser extent, the camel is thus protected; added to his excellent sight, he possesses a scent so keen that he is reported to be able to smell water at a considerable distance.

The elephant one would imagine to be sufficiently powerful to pay little heed to possible foes, but even this gigantic beast is alert at all times, and eager to avoid an encounter with one of the larger cats. Its sight, as might be guessed from the small size of its eyes, is poor. Its scent is extraordinarily keen, but, above all, its hearing is very highly developed. Its gigantic ears, acting as giant ear-trumpets, are ever on the alert to catch the slightest sound.

Does it not seem somewhat peculiar that two totally dissimilar water-loving animals, the hippopotamus and the crocodile, have eyes of very similar design? In both

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cases they may aptly be described as bulging, and the reason for this is that the animals may lie in hiding quite below the surface of the water, with the exception of their bulging eyes and nostrils ; thus they are exceedingly difficult to detect, but, at the same time, can see all that goes on around them.

A very cursory survey of the animal kingdom will suffice to show that nearly every animal, whatever its colour, is lighter below than on its back. The reason for this is easy of explanation. A shadow is cast by the animal's body ; so that, being lighter underneath, this shadow, which would render the animal conspicuous, is neutralised. No words could explain this colouring so well as it is demonstrated by two models side by side in the Natural History Museum of London. The models consist of a pair of birds in a glass case with base, back and sides of pale grey. The birds themselves are made of the same material as the lining of the case and the same colour. One bird is self-coloured, the other is white underneath. Viewed from a distance and illuminated by the light which enters the top of the case, the self-coloured bird, by reason of the shadow underneath it, can easily be distinguished from the background ; the other bird, the one which is lighter beneath, can only be distinguished from the background with the greatest difficulty.

Some animals are practically self-coloured ; the lion is one ; but the lion follows up his prey by crawling along close to the ground, so that his under parts are hidden from view. Other animals, and they are not many, are lighter above than below. The queer little water boatman has a light-coloured back and a dark-coloured abdomen, yet he conforms to the general rule of colouring, for he swims on his back and so his lighter parts are underneath.

Recognition or identification marks are nearly as common amongst the quadrupeds as amongst the birds. Several deer, the wapati is one, have white patches on the rump ; the rabbit is an example which everyone may see.

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The colouring of certain bats is peculiar. In general they do not agree with the common colour scheme in being lighter coloured below. Such colouring would be of little advantage to them, for against the twilight sky they could easily be seen from the ground in any case. Being dark above, however, renders them more inconspicuous when viewed from above, with the earth as a background, and this helps them in some degree to avoid the attentions of night-flying owls.

Usually bats have little to fear from enemies while they are on the wing, so they do not need to assume protective colouring. By day most of them lurk in dark caves and other places which are badly illuminated, and their sombre colours again come to their aid. Certain bats, however, are peculiar in their resting-places; instead of shunning the light, they rest in exposed situations, so that some sort of protective colouring is an essential.

The plantain bat of India and Ceylon is such a creature; all the fur on the upper part of its head and body is light orange, below its body is still lighter coloured, and its wings are orange and black. On the wing it strangely resembles a huge moth. By day this bat conceals itself in the folded leaf of a plantain, and the bat so closely resembles the ripe fruit of this plant that detection is difficult. We should explain that in the countries which the little animal inhabits the plantain fruits all the year round, furthermore, the bat closely resembles the decaying leaves of the plant.

Another animal from the same countries, by name Hodgson's bat, is also orange and black. This creature frequents the evergreen longan-tree, whose decaying leaves and fruit harmonise admirably with the animal which hides among them. A West African bat has a curious, and at present unexplained, colouring. Its wings are white, but they only show during flight. At rest, with folded wings, there is nothing peculiar about the colouring of this animal.

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A Central and South American bat is silvery grey in colour, but its unusual hue is easily accounted for by the fact that, when at rest, it clings to the under sides of the coco-nut palm leaves, with which it harmonises to a remarkable degree.

Most curious bat of all is a bat hailing from Africa. It is curious in habit, unusual in colouring and remarkable in the manner of its colouring. It possesses the very unbatlike habit of hunting its prey, which consists of grasshoppers, etc., by day. Its fur is dark, but, in order that it may not be so conspicuous, and may be rendered more like a butterfly than otherwise would be the case, it dyes its fur, just before it makes a flight, in the following curious manner. On its rump there is a gland from which it can and does eject an orange-coloured powder; this powder is sticky and adheres to its fur so thoroughly that the creature is, in this extraordinary manner, changed from a dark-coloured to an orange-coloured bat.

One would think that the sloth would fall an easy prey to animals searching for a tasty meal. Of this animal it has been said: "One cannot look at the creature without thinking that Nature has but poorly equipped it to live in this murderous world. Its countenance is a picture of complete and far-reaching stupidity, its bodily form the acme of four-footed helplessness. It can neither fight, hide, nor run away. It has no defensive armour, not even spines. It is too large to live in a hole in a tree, and too weak to dig or burrow in the earth. It is too tired to walk on its feet, as the monkeys do, so throughout its queer life it hangs underneath the branches of the trees in which it finds its food."

The great naturalist Buffon was even more downright in his description of these animals, of which he said: "One more defect and they could not have existed." How, then, does so inert an animal manage to evade its enemies? By growing green algæ on its fur and thus closely resembling the trees in which it dwells, even to a

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dark oval mark in the centre of its back, which resembles the end of a broken branch. Of the animals which defend themselves against their enemies by giving off foul-smelling liquids, the most notorious is the conspicuously marked American skunk.

One might reasonably imagine that such a huge beast as the cachalot whale, commonly seventy feet in length, would be free from the awkward attentions of the creatures which share its watery home. Yet even the whale has its enemies, which are usually wise enough not to attack him singly. A combat between a sword-fish and two killers is recorded in *The Romance of the Animal World* by the late Mr Edmund Selous. The sword-fish first attacked the whale, aiming for his heart; the whale avoided the blow and, with a deftness remarkable in so large a beast, caught his adversary in his mouth and bit him completely in half. The two killers then joined in the attack, but the cachalot, with a mighty blow of its tail, stretched one of them dead on the surface of the sea; the other killer sought safety in flight, pursued by his mighty adversary.

CHAPTER XVII

ENGINEERS

THERE are certain animals which have justly earned the title of engineers. The most noted of these ingenious beasts is undoubtedly the beaver, once common in this country, but now, alas! not only a stranger to our land but rapidly becoming extinct in its last remaining strongholds. In Yorkshire the beaver once held sway, and the city of Beverley is so named on account of its association with these animals. Other towns bear witness in the same manner to the fact that beavers were once common in their neighbourhoods.

Of the two species of beaver, the European is rapidly becoming extinct, and the North American will assuredly enter the list of the beasts that have been, before the world is many years older. There are no quadrupeds more social than these; others, it is true, live together in large communities, the prairie dogs, rabbits, wolves, peccaries, but none work for the benefit of the whole community as do the beavers.

That we may better understand the reason for the beaver's activities, let us examine the creature himself for a moment. His compact fur, his webbed feet and paddle tail are all adaptations for a life in the water, and, as we shall see, all the beaver's energies are devoted to an attempt to provide himself with water, the element he loves so well. It is customary for the beaver to dwell in a village, a village of huts built by himself and his relatives. Sometimes beavers are found dwelling alone; they are lazy individuals who have been driven out of some village by their more industrious fellows. In each hut there are usually about six individuals, father, mother and children.

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When the latter are three years old they forsake their family home and set up housekeeping on their own account. Sometimes, however, the village becomes overcrowded; then the older members of the community migrate to another spot, leaving the youngsters in sole possession of the abandoned huts.

The engineering proclivities of the beavers are directed to the building of huts, or lodges, as they are termed, and to the construction of dams. The lodges are of three kinds, according to their situation, but, in general, they may be considered as dome-shaped coverings to one end of their burrows. The dams hold back the water of the streams in whose vicinity the lodges are built, and there is good reason for their construction, as we shall show later, quite apart from the fact that the beaver always prefers swimming in water to walking on land, so much so that water is an absolute necessity for him.

The building of the beaver's dam is one of the most ingenious performances in the whole of the animal kingdom. In the first place, trees must be felled, and the beaver is no mean woodman. Provided with chisel-like teeth, he has no difficulty in gnawing the hardest wood, and this he proceeds to do by sitting on his haunches and cutting a deep groove right round the tree. As he gnaws the groove deeper and deeper, so he widens it, till, eventually, the tree is given a waist. This stage of the operations is an anxious one for the beaver and the subject of considerable thought. He has no wish to be injured by the falling tree. With wonderful instinct he divines on which side the tree is likely to fall, so, from the safe side, he gives a few deep bites and the tree is felled.

When once this part of the work is completed the beaver loses no time in cutting the timber into logs about a yard in length, gnawing the wood just as he did when felling the tree, with the result that the logs, when cut, have rounded or almost pointed ends. All these logs are used in the construction of the dam, and the design of this

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structure varies according to the force of the current in the stream to be dammed. When the stream is slow running the dam is built straight across from bank to bank; in faster-running streams the dam is somewhat V-shaped against the stream to break the force of the water.

The dams vary in size from quite insignificant little structures to solid masonry, two to three hundred yards in length and ten or a dozen feet thick. The first care of the little engineers is to remove all the bark from the felled logs; this is hidden away in safe keeping and serves as food when other provender is scarce. The bare logs are carried by the beavers to the bed of the stream and there they are covered with mud and stones. Hundreds of logs are used, all of them being laid horizontally beneath the water, and rendered more secure by having slender branches from the felled trees twined round them. Mud, logs and branches form a barrier which effectually stems the current and maintains the water at a constant level. In addition, much floating material, carried down by the stream, is arrested by the dam and adds to its stability.

The reason of all this activity is not far to seek when we examine a beaver lodge. Now the lodge, as we have said, covers one entrance to the beaver's burrow; the other end opens into the water some distance below its surface. We can easily realise the importance to the beaver of always having the water at constant level. Should the height of the water vary, it is likely that, in dry weather, the normally sub-aquatic entrance to the burrow would become exposed and thus form an open invitation to all and sundry to enter the lodge.

Again, the country inhabited by beavers is cold in the extreme at certain periods of the year. The streams freeze, so that, if its inmates are to have free access to their lodges, it is highly essential that the entrances should not be frozen, and this is brought about by their

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being well below the water-level—usually about four feet below.

The lodges are roughly constructed of twigs, branches and logs piled higgledy-piggledy and plastered freely with mud. In outline these structures are nearly circular and in elevation dome-shaped, the diameter being twice the height as a rule. The inside of this dome-shaped home measures about six feet in diameter and three feet in height; a generous store of grass forms the comfortable lining. From time to time the lodges are enlarged; the wood of which they are constructed decays with the passage of time and is removed from the inside by the beavers and additions to compensate for its loss are made on the outside. These lodges are mainly used as winter homes; in the summer most of the colony spend their time swimming about in the neighbouring streams.

The musquash or musk-rat, another North American animal, is not unlike its relative the beaver in habits though as an engineer it is not nearly so ingenious. A dweller by streams and ponds, the musquash, like the beaver, is by instinct a burrower, and his burrows are much more complicated than those of his cousin. In the bank of some stream the musquash tunnels freely; the mouth of each tunnel opens below water; many of them are very long, often as much as sixty feet, and all of them slope gently upwards to open into a common chamber, which forms the musk-rat's dwelling-room.

The huts which these animals build are merely huge piles of grass and other vegetation, from three to four feet in height, to which the owners have access by burrowing an opening into them. The outsides of these heaps of vegetation are freely plastered with mud; inside, the musquash spends the colder months of the year, eating away the walls of his residence meanwhile. A musquash hut, then, is merely a storehouse of food, within which its owner dwells so long as the food supply lasts.

A third engineer is also, curiously enough, a native of

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North America. We refer to the moose or elk. Although this animal is the largest of the deer, it is not without its enemies. During the summer and in the depth of winter the moose is well able to take care of itself. It is powerfully built, with massive horns and a gait which carries it over the ground at no mean pace.

At the end of the winter, when the thaw sets in, this enormous deer must make provision against its enemies; its very size and weight are disadvantageous, for at every step it sinks knee-deep into the soft snow. The time has arrived for the moose to build a "yard," which consists of a rampart of snow, sometimes four or five miles in diameter, within which the snow is trodden down in a series of paths which form a veritable network running in all directions. Inside the "yard" the herd of moose dwell in perfect safety till the winter snows have passed and warmer weather sets the animals free from their enforced confinement.

CHAPTER XVIII

SAPPERS AND MINERS

VAST numbers of the world's quadrupeds are, by profession, sappers and miners. Examples of four-footed beasts which go to earth are to be found everywhere. One cannot take a stroll into the country in any part of Britain without encountering the work of some energetic burrower.

Of all the dwellers in darkness none is more adept in his work than the mole, none better adapted for the life he leads. Practically devoid of sight, with fore-feet like shovels and highly developed muscles in his fore-arms, a sharply pointed, hard nose, and a fur to which the soil will not adhere, and of such a nature that it cannot be rubbed the wrong way, for the reason that there is no wrong way with the mole's fur, this little miner is made for his job.

Let us state at once that the familiar mole-hills, so injurious and disfiguring on farm land, are not the sites of the mole's underground dwelling. The animal works near the surface of the soil as a rule, so near that his movements can be followed by watching the tremors of the earth above him, just as one may trace the course of a water animal, without actually seeing it, by the line of ripples on the water. The mole-hills are simply heaps of excavated earth which the little animal throws up to the surface of the ground from time to time.

The mole fortress is a structure of ample dimensions, far larger than a mole-hill at any rate, and often attaining a diameter of three feet or so. As a rule the animal is at little pains to conceal its habitation, an oversight that often recoils on its own head, for the watchful farmer is

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ever on the alert to destroy this our foremost sapper. The mole appears to have no choice as to the kind of soil in which he burrows, and he first digs a round cavity a very little way below the surface, pushing the earth to the surface as he works, through an oblique tunnel. "When this superincumbent earth has reached an inconvenient height another tunnel is made, sometimes from another part of the next cavity, but more often sideways, from the first upward tunnel. All this takes time, and the mole meanwhile makes fresh runs from the fortress, the seat of its labour, in various directions in search of food. Much of the earth displaced in making these fresh runs falls into the nest cavity, and has to be disposed of in the same way as before. Now the tunnel (or tunnels) leading upwards from the nest cavity becomes longer and longer, winding round under the surface of the growing fortress.

"The tunnels in the fortress are for two distinct purposes : (a) Tunnels to eject earth from the nest cavity and bolt run. These are generally in the shape of a corkscrew ascending from the nest, and often diverging into blind terminals. (b) Tunnels not connected directly with the nest cavity, but traversing the fortress from runs outside it. Through these tunnels the mole has brought the earth to heap over the nest, and they seldom occur except in boggy land, where the nest is of necessity near the surface of the ground, or even in the centre of the piled-up mound.

"The nest cavity is roughly spherical, about the size of a large cottage loaf, and quite smooth from constant friction and use. The nest, which completely fills the nest cavity, is a ball of grass or leaves, or a mixture of both. I have found a nest made entirely of dead beech leaves, others entirely of dead oak leaves, and when it is remembered that the material must all be brought in by the mouth the amount of labour required can be appreciated. When the nest is taken out bodily, it has to be

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unwound (if made of grass) to find the centre. There is never a hole apparent, and not only is the nest always found closed when the young are within, but in all cases, even when old and long deserted. When dry grass is not obtainable fresh green grass is used, which soon withers and gets dry with the heat of the mole's body. When a nest containing young is found it is invariably infested with fleas and mites.

"Nearly every fortress has a bolt run, by which the mole can escape when surprised in the nest. This run leads downwards from the bottom of the nest, and then turns upward and out of the fortress by a tunnel of its own, and is very rarely connected with any of the other numerous exits of the fortress. The only fortresses that I have seen without the bolt run have been on marshy land, where such a tunnel would have led to water."

The mole is an energetic sapper, a plucky fighter and a glutton. A popular writer on natural history once pictured a mole magnified to the size of a lion, and he visualised a beast more terrifying, more greedy and more energetic than anything that has been seen upon the earth; he is, at all events, in his actual living form *the* burrowing mammal.

Before we mention the animal which is usually considered to typify cunning, let us spare a little space for the wolverine or glutton, the most cunning of all quadrupeds. So wily is he that to trap him is wellnigh impossible; he is even impertinent enough to feed upon the trapped animals of the North American hunters. The wolverine will also enter any temporarily vacated homestead and remove all the portable articles to the neighbouring brushwood. Exactly the object of so curious a proceeding is not clear.

The fox, as befits so cunning a creature, often avails himself of the rabbit's burrow. True, the rabbit is a smaller animal than the fox, but he makes a wide tunnel for his size and one which the fox can easily enlarge to



POCKET-GOPHERS IN THEIR HOME

These peculiar creatures spend their lives underground, like the mole. The animal in the upper division of the illustration is represented thrusting a mass of earth out of its burrow. In the lower division the interior of the "living-room" is shown; the animal on the left is stretching the opening of a pocket with one paw while it thrusts in a fragment of potato with the other. The young pocket-gopher on the right is eating in a characteristic attitude, the food being held between the paws. Just behind it, the opening of the tunnel which connects the living-room with the animals' store-room may be distinguished.

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meet his needs. Being a much-persecuted beast, the fox usually sees to it that there are several exits from his earth, as his burrow is called ; he also provides himself with more than one earth, so that when he is driven out of one home he may seek another. When his home is the result of his own labours it is usually nothing more than a simple tunnel ; should he have purloined the residence of some other sapper, he takes things as he finds them, and never alters the dwelling to suit his needs.

His cousin the Arctic fox is a much more expert miner. These foxes are of semi-social habits, crowding together after the manner of rabbits, yet one family keeps its home separate from its neighbour. Their burrows are always driven deep into the earth, for the better protection of their owners against the biting cold. At the termination of the entrance tunnels, for there are always several of these, is a large dwelling chamber ; from this chamber a short tunnel leads into a smaller chamber, the nursery for the young. Frequently the entrance tunnels are connected with one another by cross borings, so that the whole structure is exceedingly complex.

After the mole our greatest native sapper is undoubtedly the badger, formerly, and still in some parts, known as the brock, hence the names Brockenhurst, Brockley and a few others. The badger is shy ; he rarely ventures forth by day, though we have seen him in playful mood towards evening in a little-frequented part of Yorkshire. As we have noted with our other sappers, the badger's dwelling contains several exits ; half-a-dozen or more are not uncommon. Some of these side tunnels, it is presumed, are built for ventilation purposes ; at any rate the badger rarely makes use of more than two or three of the many ways into his home. Each entrance is widely separated from the others, each tunnel may extend as far as thirty feet, and all the tunnels meet in a common chamber five or six feet below ground-level. That some of the tunnels are simply air-shafts is rendered more probable by the

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fact that some of them lead vertically upwards to the open air.

By far the commonest of our British burrowers is the rabbit. His home is too well known, and he himself is so familiar, that there is little need to describe his work in any detail. Like the Arctic fox we have just mentioned, and the prairie dog we are about to describe, the rabbit is of social habits. Their warrens are formed in any spot where the soil is suitable for digging, and where they have a reasonable chance of being unmolested. The home of this common animal comprises a living chamber in which the young are reared and, approaching thereto, is a veritable labyrinth of tunnels, the inevitable bolt hole never being omitted.

The prairie dog, which, by the way, is not a dog, but is so called on account of its peculiar little yelp, dwells with its friends and relations in a village. A village, be it said, is merely a warren, a plot of land riddled in every direction by the tunnels of these little creatures, and altered in appearance by the earth mounds which they throw up at the mouths of their burrows.

The work of the prairie dog is not carried out at haphazard, as is apparently the case with the common fox and the rabbit, but is modelled on a definite plan. Each burrow enters the earth at an angle of about forty-five degrees and runs downwards for five feet or more; then it turns suddenly almost at a right angle and ends in a chamber, the home of the prairie dog, which is often shared by the burrowing owl and the rattlesnake, to the undoing of the young prairie dogs. Usually there is a bolt hole, but not invariably. Well-worn paths run from the entrance of one burrow to another, for the "dogs" are very sociable and constantly visit one another.

Their villages cover enormous areas in the arid wastes of North America; in fact these animals can live in districts absolutely devoid of water. Towards autumn all is quiet in the village, the little yelping sentinels,

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which have perched themselves on the tops of their mounds, ready to give the alarm signal to the rest of the villagers, throughout the hot summer months, are gone, and each prairie dog family has closed its front door and retired to the inmost recesses of its burrow to enjoy a long winter sleep.

Another expert North American miner is the natty little chipping squirrel, so called on account of its odd little cry. Its burrow is of the most complicated description. For a yard or so it ascends perpendicularly and then turns upwards, winding about in a sinuous manner. At the end of this winding underground pathway there is a chamber which is at once living-room and nursery, for here the mother squirrel constructs her warm, comfortable nest of dried leaves. From the main burrow several galleries are run; some to serve as means of escape from possible enemies, others to form layers in which the little creature may store up food for some future day. Although the squirrel is a tiny creature, it is an ardent food hoarder, and in one larder were discovered "two quarts of buckwheat, some grass seeds, nearly a peck of acorns, some Indian corn and a quart of braked nuts" (a species of beech-mast).

The habit of building sinuous tunnels is one not easily explained; sometimes force of circumstances, in the shape of a large stone or a tree root, will compel a burrowing animal to deviate from its course. Often, however, these animal sappers will make winding burrows when there is nothing apparently to prevent them from going straight ahead. Such a miner is the duckbill of Australia, most anomalous of animals from that land of animal anomalies.

The duckbill is possessed of a bill like a duck, its name tells us as much, and feet strangely resembling that bird's; moreover, it lays eggs; yet withal it is a mammal. As might be guessed from an inspection of its strongly webbed feet, the duckbill is an expert swimmer and as such makes its burrows in the bank of some favoured stream. To

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every duckbill burrow there are two entrances, one above and one below the water-level. The former is always situated beneath a clump of vegetation, so that detection is wellnigh impossible. From below the water the tunnel ascends at a fairly sharp angle, but it winds hither and thither through the soil of the river bank and in all is many feet in length. It terminates in a broad oval chamber, which is well stocked with dried grasses. The young duckbills remain in their underground nursery till they are more than half grown, and it is lucky for them that their parents will tend them so long, for they are helpless little creatures.

The majority of miners mine for the express purpose of etting up housekeeping below ground. The mole combines this peaceful avocation with underground hunting expeditions, for he will tunnel hither and thither in search of succulent worms. The curious little North American pocket-gopher combines domestic affairs with the search for food, but, being a vegetarian, his methods are rather different to those of the mole. This little miner is fond of the roots of plants, and much of his burrowing is conducted with the express object of satisfying his craving, which he is enabled to do, as he meets with various roots during his underground travels.

The four paws of the pocket-gopher are strong, large and armed with formidable claws ; they are, in short, admirable digging tools. The most remarkable fact about the structure of these little creatures is their possession of a roomy, fur-lined pouch on either cheek. We have said that the pocket-gopher mines below ground in search of tree roots ; in doing so he keeps about a foot below the surface. In his wanderings it is only natural that, sooner or later, he will encounter the labyrinth of roots belonging to some tree. This is just the spot he likes for his nest.

To tunnel downwards beneath this shelter for a depth of five feet or so below the ground-level is the work of a very short space of time for such a powerful sapper. At

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the end of this tunnel a large chamber is built and in it the nest of dried grass is constructed.

A second passage leads from the nursery to the larder, which the pocket-gopher always keeps well filled. Powerful as are the fore-feet of this little animal, its teeth are also brought into play when it is mining; they are made to serve as a pick to loosen the earth. "At the same time the fore-feet are kept in active operation, both in digging and in pressing the earth back under the body, and the hind feet are also used in moving it still further backwards. When a sufficient quantity has accumulated behind the animal, he immediately turns in the burrow, and by bringing the wrists together under the chin with the palm of the hands held vertically, forces himself along by the hind feet, pushing the earth out in front. When an opening in the tunnel is reached, the earth is discharged through it, forming a little hillock."

Concerning the use of the cheek pouches Dr Merriam thus describes the behaviour of a captive pocket-gopher: "After satisfying the immediate demands of hunger, it was his practice to fill one or both cheek pouches. His motions were so swift that it was exceedingly difficult to follow them with sufficient exactness to see just how the operation was performed. If a potato was given him, or a piece too large to go into the pouch, he invariably grasped it between the fore-paws, and proceeded to pry off a small piece with the large lower incisors. He would then raise himself slightly on his hind legs and hold the fragment between his fore-paws while eating, for he usually ate a certain quantity before putting any into the pouches.

"As a rule one pouch is filled at a time, though not always, and the hand of the same side was used to push the food in. The usual course is as follows: A piece of potato, root, or other food is seized between the incisor teeth, and immediately transferred to the fore-paws. The piece is then rapidly passed across the face with a sort of wiping motion, which forces it into the open mouth of the

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pouch. Sometimes a single rapid stroke with one hand is sufficient ; at other times both hands are used, particularly if the piece is large. In such cases the long claws of one hand are used to draw down the lower side of the opening, while the food is poked in with the other.

“The most remarkable thing connected with the use of the pouches is the way they are emptied. The fore-feet are brought back simultaneously along the sides of the head until they reach a point opposite the hinder end of the pouches ; they are then pressed firmly against the head and carried rapidly forward. In this way the contents of the pouches are promptly deposited in front of the animal. Sometimes several strokes are necessary. I have never seen them emptied in any other way.”

CHAPTER XIX

NEST-BUILDERS

QUADRUPEDS are not, generally speaking, proficient nest-builders. Perhaps we unconsciously compare their efforts with those of the birds, who, as architects, are beyond compare. Frequently the four-footed nest-builders are more interesting in the methods they employ for building their nests than in the results they obtain. A builder of this type is the pencilled bettong or brush-tailed rat kangaroo, a native of Australia. About the size of a hare, with a tail nearly a foot in length and tufted at the end, this pretty brown kangaroo rat is an ingenious architect.

Let us not run away with the idea that quadrupeds or birds, when about to build, select a site at haphazard. We have mentioned the diligent search of the reed-warbler in its attempts to find a suitable clump of reeds for the foundation of its nest, also we noted the anxiety of the golden oriole that all should be well. Probably all builders, furred and feathered, give more thought to the matter than we might surmise; certainly the brush-tailed rat kangaroo hunts high and low to find a hollow in the ground near a high tuft of vegetation, for this is the kind of spot it loves so well. A suitable depression having been found, the little animal proceeds to roof it over with grass and leaves, which it is often compelled to carry from a distance. Having wandered from her home to collect nest-building material, the little animal gathers together what she requires, rolls it into a bundle with her tail and, wrapping it tightly round her burden, hops away with it to her nesting site.

Now this crude nest may be used for a dual purpose, as

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a home for the upbringing of the young and as a resting-place for the adults; the former is probably the chief object of its construction. The brush-tailed rat kangaroos are nocturnal in their habits, and they spend the hours of light within their nest, after having carefully closed the entrance, by means of a tuft of grass, before retiring to rest. Their little homes are very difficult to detect, built as they are amongst long herbage and never, by any chance, being situated at a higher level than the surrounding vegetation.

Another Australian nest-building quadruped is the rabbit-eared bandicoot. About the size of a rabbit, with long, broad ears and hind legs of such a length that its gait is awkward, yet it cannot leap like the kangaroo. The rabbit-eared bandicoot is one of the oddities of nature. It frequents ground broken by scattered tufts of vegetation, just the districts favoured by the rat kangaroos, and the nests of the two animals are very similar. If anything, the bandicoot is the more adept at concealing its abode.

A far more proficient architect than either the bandicoot or the rat kangaroo is our little harvest mouse. This diminutive creature is one of the smallest quadrupeds known, weighing, when full grown, little more than a sixth of an ounce. He is a familiar object of wheat-fields with his rich red-brown coat, which gives place to clear white below.

The nest of the harvest mouse is an elegant and comfortable structure; the materials of which it is composed may be wool, rags, hair, moss or feathers, though, usually, the little builder looks no further for its nesting material than the grass and leaves amongst which its nest is suspended. These leaves it plaits and weaves with consummate skill, tearing the broader leaves lengthways, that they may better be used in its scheme of nest construction. The completed nest is a little larger than a cricket ball, of similar shape and beautifully neat and compact; its

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hollow interior is lined with vegetable down or some other soft material.

When the nest is temporarily untenanted or contains young ones which the mother has left, for the time being, to their own devices, there is apparently no entrance, for the reason that the little door of the nest is covered, by the mother mouse, with grass or with whatever material is used in the construction of the nest. The trim little sphere is usually attached to stout grass stems or to wheat, occasionally even the branches of a low shrub or the leaf stalks of a thistle may act as a support, but always the nest is placed at some height from the ground. The little mice are good climbers and very active, as may be gathered from the fact that they gain a livelihood by capturing bumble-bees and insects of the like kind. Though so exquisite a nest-builder, the little harvest mouse spends its winter in a hole below ground.

Squirrels' nests, mainly by reason of their larger size, are better known than the more finished home of the harvest mouse. Though apparently roughly constructed, closer inspection will show that the squirrel deftly weaves together the twigs, leaves, grass and pieces of bark of which its nest is composed. Moss and leaves form the lining, and the whole structure is roughly spherical in shape, with an opening at the side. The roof of the nest, despite its apparent flimsiness, is absolutely rain-proof. It is a peculiarity of squirrels that they build more than one nest at a time, with what object it is not quite clear. Should, however, the inhabited nest be disturbed whilst tenanted by the young squirrels, the mother promptly removes them one by one, in her mouth, to one of the other nests, which may be nothing more or less than a converted magpie's nest.

The dormouse is a very neat little nest-builder. Selecting a site in some shady bush, the industrious little creature gathers together a store of dried grass and leaves for the construction of its home. The completed structure

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is oval in shape and so deftly concealed is the entrance hole that it is impossible for the inexperienced eye to find it. Seeing that the dormouse sleeps for the greater part of the day—his name implies that he is a sleeper—he probably pays very special attention to his nest, that enemies may not fall upon him during his siesta. The dome of the nest is constructed loosely of interlaced grass leaves; the lower half of the nest is made of finer grass, and very special care is bestowed upon its weaving; often, indeed, these fine grasses are bound together with the stems of climbing plants. The door which covers the entrance to the nest is formed of grass leaves, ingeniously arranged to exclude intruders.

The short-tailed field-mouse builds a summer nest which is deserving of a few words. Placed on the ground in a little hollow in the earth, and usually hidden by a clump of grass or other herbage, it is by no means easy to find. The building material is grass, nibbled into small pieces and shredded, so that it appears like flax or some similar fibre. Of door to the nest there simply appears to be none, so skilfully is it concealed.

The common mouse is not so particular as its relatives; it will build in the most unlikely places; no situation, no material comes amiss to him. His natural building material consists of dried grasses. In his semi-domesticated state he will make use of paper, string, material of all kinds and even dress clothes, as the author can testify to his cost. The nests are placed in drawers, bottles, upturned flower-pots and the like; even the homely loaf of bread does not come amiss; in fact there is an authentic record of such a site being selected. A newly baked loaf of bread was put away and, on the following day, a hole was observed in the loaf. Further examination revealed the fact that a mouse had built a nest of paper therein, and deposited a number of youngsters. Incredibly quick work for the loaf to cool, the cavity to be eaten away, the

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paper nest to be built and the young to be born—all in the space of thirty-six hours!

The man-like apes are all crude nest-builders, but in no case can they be considered as permanent structures; in fact, when the food supply of the district is running short a move is usually made to another district and a new nest is built. The chimpanzee builds his nest of branches, which he bends and breaks to suit his purpose and intertwines them so that they form a fairly substantial platform, usually about twenty-five feet from the ground. Report has it that the male does not share the nest with his mate, but that he rests on a branch below, where, at anyrate, he finds shelter from the tropical rains.

Another kind of chimpanzee builds a more elaborate nest, if it can be called a nest, by tying twigs and branches to the trunk of a tree by means of the stems of creepers. This structure merely forms a shelter from the inclement weather and the apes themselves rest on a branch beneath their building. Males and females have separate shelters, and in neither case will they build in a tree which has any branches near the ground, their choice of tree being prompted no doubt by the probability or otherwise of some enemy ascending. Immediately the shelter fails to keep out the rain another is built.

The orang-outang is no better nest-builder than his cousins. He simply makes a platform of small branches, laid side by side, after having been bent double in the middle. To make his nest more comfortable he gathers leaves to upholster his couch. Not so very long ago the orang-outang in the London Zoo escaped from his cage. He promptly took up his abode in the nearest tree and all attempts to dislodge him failed. While enjoying his temporary freedom he was by no means idle, for he tore the branches from the tree and, bending them in characteristic manner, built for himself a nest on which he took his ease and from which he surveyed the world at large, till hunger forced him to come to

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the ground, when he was captured and once more made a prisoner.

Whether the gorilla does or does not construct a nest is a moot point. By some observers he is said to build a nest of reeds and moss, not far from the ground or even upon it, and to guard it whilst the female and her young rest upon it.

CHAPTER XX

SEASONAL CHANGES

"A LIVING animal is almost always either acting upon its surroundings or being acted upon by them, and life is the relation between two variables—a changeful organism and a changeful environment." We ought, therefore, to consider animals in relation to their surroundings. A very slight acquaintance with nature will show us that there are certain changes which may be ascribed to the cycle of the seasons. The shedding of their antlers by deer, the courting plumage of birds, the winter coats of the ermine and mountain hare, the hibernation of the dormouse are one and all due to outside influence. The seasons bring with them, in the main, changes of temperature, heat and cold alternate, and these variations in temperature have their direct effect on animal life. Indirectly animals feel the changes of the seasons; at certain periods food is scarce, at others plentiful. Other externals besides the effects of the seasons play their parts in moulding the lives of the creatures of the earth.

Changes of temperature have very marked effects upon most living beings. Some of these effects are obvious, as, for instance, the assumption of white plumage by the ptarmigan, and the paling of the fur of the variable hare or of the stoat. Sometimes these effects are not so obvious and can only be determined by experiment similar to that of Maupas, who experimented with a single-celled animal, one of the lowest in the animal kingdom.

Let us hasten to explain that these lowly creatures increase by dividing themselves into two parts, each half forming a new individual. Now Maupas found that the particular organism in which he was interested divided

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once a day, when the temperature of the water in which it lived was between 7° - 10° C.; with an increase of temperature to 10° - 15° C. division occurred twice a day; at 15° - 20° C. thrice; at 20° - 24° C. four times, and at 24° - 27° C. five times. At the last temperature one individual in four days became the father of a million, in six days of a billion, in seven days of one hundred billions, weighing one hundred kilogrammes. In short, cold lessens vitality; its usual accompaniment also is a reduced food supply.

Nowhere in the animal kingdom can the combined influence of warmth and plentiful food, as opposed to cold and a deficient food supply, be studied to more advantage than in the case of the green-flies or aphides. In the summer, when the weather is warm and food abundant, these creatures multiply in a phenomenal manner and at an extraordinary rate. All the individuals are females and bring forth their young without the aid of males—the most rapid form of animal increase. Every few hours, for days on end, the mother aphid produces her young. So astonishingly rapid is the increase that, accidents apart—that is to say, if all her offspring survived—she would be at the end of one year the mother of a family whose combined weight would more than equal that of 500,000,000 men.

With the advent of winter, food becomes scarce and the temperature is reduced; as a result, males appear and the birth-rate is reduced so rapidly that, were the aphides but human, columns would be written in the newspapers suggesting wild remedies and drawing attention to the serious state of affairs. But the return of summer sets the ball rolling again for the aphides; in fact, certain specimens which were kept in a greenhouse, with plenty of warmth and abundance of food, never slackened their family affairs for a single day during a period of four years.

The question of food supply is a very important one

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to all animals from the highest to the lowest. Ill-nurtured humans are often small and stunted, and the same is the case with the lower animals. An insect which in its larval stage has had little or unsuitable food will produce an adult considerably smaller in size than another insect of the same kind which has been fortunate enough to find abundant food. There are special cases, however, where fasting appears to do no harm, and other cases where it seems necessary. All the parasitic insects which are nourished upon blood can fast for extraordinarily long periods without food; fleas, ticks and the like can fast for months, and in extreme cases for years, without a bite, and this is a very wise provision of Nature, for the special food of these creatures is not always easy to obtain. At certain periods in the lives of some animals fasting is necessary, as witness the chrysalis, which never eats, and the tadpole, which fasts before it becomes a frog.

Winter, again, with its concomitant cold, is a season of fasting for many animals. The hedgehog and the dormouse, to quote common examples, simply curl themselves up in some well-prepared hiding-place and enter into a long sleep, till sunny skies call them once more to activity and food. During hibernation, as this winter sleep is called, many of the ordinary functions of the body are in abeyance, and others occur at a very much lower rate than is usual. The long rest takes place at the expense of stored-up fat in the tissues, for most hibernating animals are decidedly plump before their winter's sleep, and somewhat emaciated when they make their reappearance.

That not only the quantity but the quality of food has a marked effect upon animals is a well-known fact. It is shown clearly in the case of canaries which are artificially fed upon food containing cayenne pepper. The result of this feeding is to produce birds with orange-coloured instead of the usual lemon-coloured feathers. With the seasons, again, many animals change their diet rather

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than starve. The herring-gull leads an agricultural life during the summer, feeding upon any cereals he can find ; in the winter, when grain is at a premium, he returns to his diet of fish.

The effects of light cannot altogether be dissociated from the changes of the seasons. In winter the light is much less intense than it is in summer, as every photographer knows. To attempt to trace the subtle changes which take place owing to the reduced power of the light in winter or its increase in summer would be beyond the scope of our pages, but that light does affect animal life we propose to show. The colouring of the common sole or plaice or flounder is well known to everyone ; every fish shop in the country can show samples with which we may refresh our memories. Sand-coloured above, white or nearly so below is a description, a rough description certainly, which applies equally well to all three.

On the upper surface of these flat fish a certain amount of light falls, even in the ocean depths ; their under sides for the greater part of the day lie on the sand, and are not exposed to light, and that is the reason they are white. Now early in its career not one of these flat fish is flat. The statement sounds Irish, but it is none the less true. The plaice, for example, when young is an ordinary-looking fish, with one eye on either side, and it swims in the usual fish manner. As it attains maturity it becomes flattened, the side that is to be the lower grows paler and paler in colour and, most remarkable change of all, the eye that has appeared in danger of becoming useless owing to its position below the fish gradually grows round to the upper surface.

But all this is by the way ; we are only concerned with the effects of light. Experiments have been carried out with flounders which, instead of being permitted to rest upon the sand, as is their habit, have been illuminated from below by means of mirrors, with the result that their under sides assumed the duller hues of the upper sides.

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Fishes kept in the dark will eventually become colourless, if they survive the ordeal, as many of them will. Many creatures live normally in dark caves where not a ray of light ever reaches them; such an animal is the proteus, a salamander from the caves of Dalmatia. In colour it is a very delicate pink—in reality it is white, but its blood gives it a pink hue. Now when the proteus is brought into the light it gradually turns black; moreover, such specimens produce black young.

External influences, not directly due to changes of season, may, naturally, effect animal life. As proof of this statement there is a familiar and easily performed little experiment which anyone may try. The common tadpole, as everyone knows, will, under normal conditions, develop into a frog; in doing so it loses its feathery gills and abandons its purely aquatic life, becoming an air-breathing creature and more or less terrestrial. If, however, perforated zinc or some similar material be placed just below the surface of the water in which the tadpoles live, in such a manner that they are prevented from coming to the surface, they will retain their gills and continue to grow for two or three years, growing in that time into veritable tadpole giants.

Now there is a most extraordinary relative of the frog which is blessed with two names; it is sometimes called the axolotl and sometimes the amblystoma. It came by its two names quite by accident, and retains them more by courtesy than by right. The axolotl resembles a large newt, and its home is in the North American lakes. It has lungs and also breathing gills like a tadpole; its tail is large and flattened sideways. Now in the same lakes and on their shores the amblystoma dwells; devoid of gills, and with a lizard-like tail, it only bears a slight resemblance to the axolotl. As may be inferred, the young axolotls grow into old axolotls, and the young amblystomas into old amblystomas; on the face of it, there is nothing remarkable in that. But imagine the surprise

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of various naturalists when some axolotls which were kept in the Jardin des Plantes in Paris, finding their water supply was running short, turned into amblystomas. Then and then only was it discovered that the creatures were one and the same, that the axolotl is simply the larval form of the amblystoma, but withal a larval form which has so far developed that it can reproduce its kind, an event which is impossible in the case of the tadpoles.

The seasonal changes in certain tropical butterflies are very marked and very remarkable, as a study of this species in any good museum will show. That tropical insects should have summer and winter forms is as remarkable as is the difference between these forms. One explanation, and a plausible one, is that the changes are due to the still surviving efforts of the glacial epoch. During this epoch there was perhaps only one form—the winter form. Change of climate then produced the summer form. In this connection it is interesting to note that by keeping the chrysalids of these butterflies which should develop into summer forms in artificial cold, they will emerge as winter forms.

CHAPTER XXI

REPTILES

FOR some unknown reason reptiles are looked upon with a certain amount of repulsion by most people ; as a matter of fact, they are creatures of the greatest interest, their habits are often strange, their beauty is frequently dazzling. Maybe they are less ingenious than the birds or insects, the former of which are very close relatives of the reptiles though so dissimilar in appearance. At a casual glance the reptiles strike one as being an incongruous crew—tortoises and turtles have many points in common certainly, but the legless snakes, the lizards and the alligators and crocodiles make up a strange band of animals.

The turtles, of which one species is so much in demand by gourmands the world over, are aquatic, creatures of the sea and of rivers. They rarely leave their watery homes, except for the purpose of egg-laying. The food of many of these animals consists wholly of fish, and it is remarkable how such slow-moving, almost lethargic, creatures, whose movements below water closely resemble the flight of a bird, can capture agile fishes. We all know how the domestic cat, the familiar rabbit and many other animals are in the habit of travelling along the same route or run day by day. Many fishes also travel along the same route each day, and the turtle is not long in discovering this trait of his prey. Being a cunning creature, he partially embeds himself in the mud below the fishes' favoured way ; the unsuspecting fishes, mistaking the turtle for some muddy rock, swim near by and are instantly seized in the powerful jaws of the keen-eyed turtle.

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Some of the fresh-water turtles make their meals of frogs, and experience has taught them that their prey is in the habit of sitting by the edge of their pond, facing the shore, that they may snap up any insects that may be unwary enough to settle on the plants fringing the water. The turtles approach the frogs quietly from behind, and seize them before they have time to regain the deeper water, in which they would be able to make good their escape.

Towards the middle of the summer the female turtle devotes herself to maternal affairs. At this period she wanders far from her beloved water until she finds a situation where the soil is soft and muddy. In the mud she wallows and digs in leisurely fashion till almost buried, an operation which may occupy at least a week. Next she lays several dozen quite round, white eggs, then, pulling herself out of the slough by means of her powerful fore-legs, the mud slides back from her polished shell, leaving the eggs well covered, and her maternal duties are at an end, for she takes no more thought of her brood.

The turtle is no fool, for he knows many tricks and dodges. In deep water he can escape from most of his enemies by swimming; in shallow water he is at a disadvantage, so what does he do when danger threatens? He simply makes for the muddy bottom of his retreat and there causes such a stir that the water becomes cloudy and he is lost to view. As the mud particles settle down, the turtle keeps a sharp look-out for his enemy. Should he have taken his departure all is well; on the other hand, if danger be still present, he stirs up another mud cloud and in its shelter rapidly scrambles to another hiding-place. His action is similar to that of the cuttle-fish under similar circumstances, though his means of escape is effected in a different manner. Sea-weeds grow on the backs of some turtles; in consequence they become akin to sea-washed rocks in appearance and are well hidden from their enemies.

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The feeding habits of the edible turtle are worth passing notice. This creature feeds on a sea plant, and feeds on it voraciously, but the plant grows in shallow water and shallow water spells danger to the turtle. Having taken his fill, therefore, the ingenious turtle chops up more of the favoured plant with his scissor-like jaws, and mixes the chopped pieces with mud; this mud or vegetable mixture is then rolled into a ball about the size of one's head and floated out to sea to form a food supply to which the turtle may turn in time of need.

Some tortoises live in burrows after the manner of rabbits. The American gopher-tortoise is a case in point; in the dry, sandy southern states it is plentiful, living in regular warrens. Each burrow is sharply oblique for a yard or so, and then slopes more gently; at the entrance there is always a little mound of sand, thrown up by the tortoise during its tunnelling exploits. The end of the gopher-tortoise's burrow is a roomy chamber lined with branches of fir-trees which have been dragged in for food and warmth. A single pair of tortoises inhabit each burrow, and they subsist on the resin from the fir-trees. At nesting-time a new chamber is formed for the reception of the eggs, not at the end of the burrow as might have been expected, but near the entrance.

Large numbers of these tortoises are captured by digging holes of considerable depth just outside the entrances to their burrows. Into these holes the unsuspecting beasts tumble when they sally forth to take their walks abroad. There is nothing very remarkable about the burrows of the gopher-tortoise, but we have mentioned them because the burrowing habit is peculiar among these creatures, at least as a permanent institution. Many tortoises, however, hide themselves below ground, there the better to enjoy their winter sleep. Selecting some soft ground, towards autumn, operations are begun. The tortoise, as may be imagined, is not prone to hurry.

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Even in the softest ground it only excavates about an inch a day, and its method of working is peculiar. Instead of using its powerful fore-feet, as might be guessed, it simply edges its way by a series of side-to-side movements, till the soft earth covers its back.

The European pond tortoise is an engineer with peculiar methods. The female lays her eggs below ground, and in the digging of a hole for their reception she displays considerable ingenuity. She commences by moistening the soil with water for the purpose of rendering it soft and easily worked; then she stiffens her pointed tail and, using it as an awl, makes a hole in the ground. Next she applies her hind legs to the work and, moving them alternately, scoops up the soil till a hole is formed of such a depth that her legs can reach no farther; the excavated soil she deposits at the side of the hole. Her next proceeding is to deposit her eggs in the cavity she has made; no jumble of eggs will meet her needs, they are all carefully separated and distributed in a single layer by means of her feet. The soil is replaced over the eggs and battened down by the mother tortoise, a feat which she accomplishes by raising her body as high as her stumpy legs will permit and letting it fall upon the loose earth. By this means the ground is stamped firm and flat. Lastly, to allay suspicion, the tortoise scratches the surface of the soil slightly and, having done so, she departs and leaves her eggs to their fate.

The giant tortoise is anything but a romantic-looking individual, yet even he, despite his cold blood, has a winning way with him when he goes courting. He walks with slow and measured gait round and round the object of his affections, stopping frequently so as to face the side of her shell. Then he raises himself on high and batters the under side of his shell against the upper surface of hers a dozen times or more, giving vent to deep trumpeting calls the while. This is called courtship, but the resounding thumps are like the blows of a heavy mallet

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or sledge-hammer and look far more ludicrous than romantic.

Looking at the inert crocodiles in their tank at the Zoo, or even beholding them floating like animate logs in their native rivers, no one would guess that they, or rather some of them, are expert nest-builders. Certain female crocodiles, it is true, simply dig a hole in the sand, deposit their eggs therein and cover up the cavity. Their nests, however, are much more elaborate, and Mr Dittmar thus describes one he discovered on the banks of the Savannah river: "The nest consisted of a mound of water-soaked twigs, dead masses of the hanging moss that had dropped from the trees and other debris. The mound was about five feet in diameter and two feet high. It contained thirty-eight hard-shelled, white eggs three and a quarter inches long and one and three quarters of an inch in diameter. The eggs were collected in the middle of August and began hatching in the first week of October. They were deposited in two neat layers at the very bottom of the mound. As we dug down to them the rotting vegetable mass, scooped together by the parent, was found to be producing a considerable heat. Of the parent there was no sign during any part of the work of digging out the eggs and packing the material composing the mound into a number of bags to be shipped north."

"The American alligator is one of the few crocodilians giving voice to a loud sound—a bellow or roar. A five-foot specimen emits a series of sounds not unlike the 'mooing' of a cow, though shorter and more guttural. A ten or twelve foot specimen lets out a rattling bellow that shakes the night air of the lagoons and may be heard for a mile. When so performing, the males emit vapoury jets of musk from the glands on the chin. This saturates the surrounding humid atmosphere, then, travelling on an indolent air current, attracts company to the solitary bellower." This habit of attracting the opposite sex by means of perfume is by no means peculiar to the alligator.

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The alligator is by no means the inert creature that he appears. As he lies, motionless, on the surface of a South American river, some favoured fare, maybe in the form of a peccary, will probably be rash enough to step upon his back. In an instant the alligator is all alert. Lashing his tail vigorously, the unfortunate peccary is shot into the air and good luck alone will save it from being precipitated into the cruel jaws of the hungry crocodile.

Equally stirring are the combats which sometimes take place between the alligators and giant anacondas, snakes which are equally at home on land or in the water. The combatants are often well matched and the struggles accordingly prolonged. The anaconda uses every wile to obtain a purchase with his tail which will enable him to put his deadly strangle-hold upon his adversary. The alligator, on his part, struggles to avoid such a happening, for he seems to know instinctively that the anaconda could and would crush in his ribs.

From alligators to lizards is not a very far cry, but there is an interesting point about many lizards that does not occur amongst any alligators. We refer to their very ingenious method of escaping from their enemies by shedding their tails. As a rule a lizard runs away as rapidly as possible from danger, and danger usually arises from some creature anxious to make a meal of the lizard. Now lizards in general have long tails, and the tail is the most likely part to be seized by the pursuer.

We have frequently caught lizards, or tried to do so and secured no more tangible prize than the reptile's tail. For directly this organ is touched the lizard can shed it without pain or inconvenience, just as a thief pursued by a constable and seized by his coat might discard the garment and make good his escape. The abandoned tail writhes and twists and squirms in uncanny fashion in one's fingers, then a wriggle more violent than the rest will set it free, so that it jumps about on the ground like some weird live thing. Should the lizard's pursuer be some animal



AN UNEXPECTED MEAL

The peccary stood on the alligator's tail, mistaking it for a tree trunk. In a moment the alligator stretched its tail round like a bow almost to its side; suddenly it let go, and whilst the peccary thus shot up was still in mid-air, it swung its terrible tail again, and knocked its now insensible prey almost into its own jaws.

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seeking a meal, its attention is diverted by this quivering, cast-off tail, thereby helping the startled lizard to make good its escape.

The sight of a fly walking upside down on the ceiling leaves us cold, as the Americans say, because it is a sight to which we are well accustomed; a lizard, however, performing the same feat would occasion some surprise, yet it is often done by the geckos, lizards with sucker-like fingers and toes. Let us quote a naturalist's description of an evening in the tropics: "For the uninitiated tourist in a tropical country there is usually an unpleasant surprise—furnished by the venturesome geckos. One generally anticipates an awakening of insect life with the coming of darkness, and he is not disappointed. Swarms of winged forms are attracted to his lamp. Great, hard-shelled beetles enter the window with a sonorous hum like from a distressed buzz-saw, dash against the lamp chimney, then flounder on the floor; moths of various sizes dart hither and thither or whirl in dizzy gyrations about the light; a colony of tiny, ghost-like things dance up and down or are instantly consumed in the flame; there is a continuous buzz varying in its cadence and taxing to the nerves of any but a naturalist, when, without warning, a silent grey form darts obliquely across the wall, jumps from the vertical surface to the ceiling over which it flies, and like a streak of light continues down the opposite wall; perhaps for a moment it may stop, exhibiting a body as long as that of a small rat, glittering, cat-like eyes and a pulsating throat. To the nervous traveller, already annoyed by the varied hordes of insects' forms, the apparition of these heavy but stealthy forms darting across the ceiling over his head is weird and startling. An attempt at capture intensifies the impression, for the strange thing darts over the walls with the ease of a gigantic fly. Suddenly it may scurry for the window and away, but if the light continues to burn, others of its kind soon appear. Thus is life in the tropics associated

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with visits of geckos that enter homes in their search for insect prey."

We can vouch for the rapidity of the geckos' movements. Time and again we have seen them basking in the sun on walls in Morocco and have attempted to catch them, but so well contrived are their sucker toes that no human hand could ever capture them as they scale some vertical wall with the alacrity of a monkey climbing a tree.

Not far removed from the geckos in the genealogical tree of the animal kingdom are the horned lizards which have acquired a habit that was long considered a myth, but one that has now been vouched for by certain trustworthy observers. We cannot describe the habit as ingenious, but it is so extraordinary that we must not overlook it. When angered, some species of horned lizard squirt a minute stream of blood from the corners of their eyes. Anger puffs them up to such an extent that their eyes literally bulge in their sockets; then, without warning, a tiny stream of blood, as fine as a hair, shoots from their eyes and travels a distance of at least five feet. The why and wherefore of this strange proceeding has never been explained.

The gila (pronounced hee-la) monster is notorious as being the only poisonous lizard. It is an evil-looking, obese, black and orange mottled beast, capable of displaying extraordinary vivacity despite its sluggish appearance. It claims attention in our pages by reason of its curious larder. We have heard of animals storing food against a rainy day, both above and below ground, in every conceivable hiding-place, but surely the gila monster's storehouse is the most curious of all, for it is situated in the animal's tail. During prosperous times the lizard is a gross feeder and its tail becomes visibly larger, till it reaches abnormal proportions. Now desert food is hard to find at times and the gila monster with its fat tail is well able to overcome times of distress and want. It

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can exist for months without taking a morsel of food ; it simply draws on the reserve fat in its tail.

The most bizarre of all lizards are the chameleons. They are tree-dwellers all and hopelessly at sea on the ground if we may so mix our metaphors. The chameleon leads an apparently indolent life ; grasping some branch firmly with its four-toed feet and steadying itself with its long prehensile tail, it is the embodiment of immobility except for its bulging, beady, swivel eyes. Let us examine these eyes for a moment. They are almost uncanny in their movements : one may look forward whilst its partner glances backward ; now both are directed straight ahead ; again, one surveys the sky the while the other scans the earth ; they move as independently as a horse's ears and are well adapted to the requirements of the immobile chameleon for they enable it to see in all directions without the trouble of moving its position.

The only time that the chameleon shows any signs of activity is when an insect settles within its reach, then the whole scene changes in a flash. It is patent that at long last the animal is conscious of his surroundings ; maybe he always is so, but he rarely gives any indication of it. The swivel eyes are directed upon the prey and for some moments the chameleon appears lost in contemplation ; in reality he is taking the measure of his victim. The reptile's mouth opens, and, with a rapidity that is astounding, his long, wire-like tongue is shot out with unerring aim and the luckless insect is conveyed to the reptile's mouth on the sticky end of his tongue. The lightning flash of the chameleon's tongue must be seen to be believed, and though the reptile is known the world over for his colour changes, changes, by the way, which are much exaggerated, his method of capturing active insect prey is far more remarkable than his change of hue.

Snakes, so repulsive to most people, yet so attractive to those who know them and have learned their habits, next claim our attention. Many of them certainly are highly

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poisonous, and in countries like India, where the natives walk barefooted, for the most part, they take a considerable toll of human life. *The Times* of 19th September 1906 stated that "a statistical paper on India issued to-day shows that in 1904 there were killed in that country by snakes and wild beasts 24,034 persons—21,880 by snake bites, 795 by tigers, 399 by leopards and the rest by other animals. The number of cattle killed was 98,582.

"The other side of the account shows that 65,146 snakes and 16,121 wild animals were killed, for which rewards of £7313 were paid."

All the poisonous snakes carry their venom in sacs at the bases of hollow fangs, and when these fangs are plunged into any substance, preferably, on the part of the snake, into the flesh of some animal, the sacs are emptied of their venom, which pours into the wound through the hollow teeth, a case of hypodermic injection, in short, and one from which our medical men took their cue.

Though all snakes exhibit an inordinate degree of cunning, they can hardly be described as ingenious. Some of them, it is true, are given to burrowing in sand, but their engineering bent is not so highly developed as it is among the tortoises even. The burrowing snake simply sinks its body into soft sand by means of undulatory movements.

The hog-nosed snake possesses a degree of ingenuity sufficient to earn him a place in our pages—he has the unsnake-like habit of feigning death when alarmed. Now the hog-nosed snake is perfectly harmless, a fact which does not prevent it from pretending to be very ferocious when in danger, in the hope, evidently, of frightening its enemies; should these tactics fail, the snake rolls on his back, opening his mouth and rolling his head from side to side, till his jaws are covered with dust or earth, then he remains utterly limp and motionless. He will stay thus for a quarter of an hour or more; but, should the danger pass, the reptile lifts his head and surveys his surroundings, darts out his tongue—an organ, by the way

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with which snakes hear, and one in no way connected with their venom, as is popularly supposed—then he rolls over into his normal position and makes away as rapidly as possible. The hog-nosed snake will not bite even if one's finger be placed in his mouth, and he seeks to frighten his enemies by a show of ingenious yet perfectly harmless bluff.

Mr Dittmar relates an amusing experience he had with one of these snakes. "While collecting in the south," he writes, "the writer had an amusing experience with the negroes, this involving the hog-nosed snake. The negroes regarded the species as exceptionally poisonous. They had never lingered by a performing specimen long enough to discover the habit of playing possum. On the way to the Savannas, across a cotton-field, a big blow adder was found crawling along a sun-baked furrow. The writer's coloured guides and assistants shouted in terror, urging that this kind of snake be excluded from the collecting bags and instantly killed. They were asked to pause, to form a large circle and witness the writer's powers in snake hypnotism.

"The writer explained he could slay the snake by a few waves of his hand, without touching it. Walking up to the snake, with a few motions of the hands he convinced the creature its hostile airs were of no use, so it soon rolled on its back, becoming apparently lifeless. A murmur of surprise came from the staring circle. The writer insisted that the 'dead' snake be passed from one to another to convince his assistants of his powers. With many uneasy motions, nervous laughter and shouting, the snake was handed around by the tail. Then the circle was told to remain perfectly quiet for a minute more, to witness a restoration to life. This provoked a heated argument that the serpent be permitted to remain dead, but the hypnotist was adamant; he wanted a *living* specimen for his collection.

"Placing the snake upon the ground, he made a few

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eccentric motions, then, removing his hands, kept perfectly quiet. Thinking danger past, the reptile rolled over, starting away. It was caught and put into a bag. The writer's idea had been to promote respect for himself in a wild, almost lawless region, but the effect was too pronounced. His assistants at once decided his powers of black art were suspiciously dangerous. They dropped away, one by one, until the ludicrous necessity was presented of changing the location of collecting in order to leave a bad reputation behind and secure men to carry the snake bags."

It may not be inopportune here to give a short account of the art of snake-charming. Maybe the ingenuity in this case is rather on the part of the charmer than of the charmed. Be that as it may, the performance possesses a wellnigh hypnotic fascination for the onlookers. We have witnessed the performance time and again in Africa, but it is to India that we must turn for the greatest development of the art of snake-charming; on that account we make no excuse for quoting the words of an onlooker at a Hindoo performance:

"Under the trees of a public square, the idlers gather about a solemn Hindoo, whose shrill-toned reed has attracted their attention. Sitting cross-legged before two round, flat baskets, he begins a refrain upon his flute. The music is strange and crooning, suggesting something strange to follow. With a bamboo stick he presently removes the covers of the baskets and several strange apparitions arise into view from a mass of tangled bodies within. These are specimens of the deadly cobra-de-capello, their hoods spread widely. While the reptiles' eyes stare with glassy monotony at the Hindoo, the spectacle markings upon their distended necks seem to cast ghastly grimaces upon those assembled for the exhibition. Seemingly imbued with a frenzy at the appearance of the snakes, the performer quickens the strains upon his flute. His body sways from side to side in time to

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the music, when the spectators behold the dreaded snakes are alike swaying to the refrain. The celebrated cobra dance is on.

"With bated breath the onlookers witness this juggling with the serpents, when there is a sudden murmur of horror. Sinuously gliding from one of the baskets is a snake of oriental hues and a head so flat and cruel that a glance would instinctively suggest its deadliness. It is a 'tic-polonga,' known among the more learned as Russell's viper, a reptile with a fearful reputation as regards the destruction of human life. With the same undisturbed expression of solemn dignity, the Hindoo quickly reaches forward and grasps this object by the neck. With the other hand he produces a fluttering fowl. Applying the snake's mouth to the squawking creature, he permits the reptile to do the rest.

"There is a flash of cottony-white jaws, and the fowl is cast upon the pavement, where it batters its wings for a moment, then lies pulsating and dying. Before the snakes have been again enclosed in the baskets the fowl is dead. In silence the Hindoo gesticulates to his observers his willingness to demonstrate as well the power of his cobras. But there is a general shaking of heads, the jingling of a few coins and the exhibition is over.

"To most of us comes a feeling of awe and fascination attending the performance of a snake-charmer. In this instance we have seen a man associating intimately with two species of snakes that have increased the death-rate of India about twenty thousand a year. The performer, apparently, had perfect control over the reptiles. Thus follows the question: Is snake-charming an art, and if so, how is it acquired?

"The greatest requisite of the snake-charmer is nerve; this must be backed by a thorough knowledge of snakes. No hypnotism figures in the business. The handling of poisonous snakes is a reckless performance. Not infrequently the snakes are 'fixed'—that is, their fangs

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have been extracted. This treatment does not render them entirely harmless ; for poison flows from the wounds left by the extraction of the venom-conducting teeth, and the palate and teeth of the lower jaw are liable to produce lacerations through which the virus may join the circulation. But it must be acknowledged that the snakes in this condition are not so liable to bite, and if they do there is considerably less danger.

“Well does the Hindoo know that if his cobras become accustomed to handling and teasing, they will dance with less energy ; so he keeps a supply of fresh and undisturbed serpents on hand. The cobra’s natural attitude of defence is, as has been previously explained in detail, a rearing posture with hood spread widely. From this position it follows with swaying motions every motion of its aggressor. The Hindoo’s swaying body elicits a like motion on the part of the snake, as it alters its position in aiming to strike. Thus is the dance explained. The shrill notes of the reed appeal only to the imagination of the spectators and, were the weird intonations to cease, the dance would continue without interruption ; for snakes exhibit absolutely no interest in music of any kind, an unfortunate fact for the writers of romantic stories.”

CHAPTER XXII

FROGS AND TOADS

INGENUITY amongst the frogs and toads is mainly directed towards the upbringing of their young. Everyone has seen the masses of frogs' eggs, known as spawn, floating on the surface of stagnant ponds in our country districts. This habit of enclosing the eggs in a jelly-like envelope is common to nearly all frogs. Sometimes the spawn is in a single string, resembling a rosary, sometimes in a double string; at other times the eggs are laid singly but still covered with the jelly, and there are many occasions when a froth resembling white of egg takes the place of the jelly. In the case of a few individuals there is no gelatinous covering.

One newt carries its eggs about with it, and as they are large and stalked they resemble a number of toy balloons on strings, in miniature. Another goes a step further in the nest-building stage; she searches about for a suitable water plant and, having discovered one, she holds some of the leaves together in a bunch with her legs and deposits an egg with its sticky covering in the bunch of vegetation. When the animal, leaving behind a single egg, leaves the water plant there remains a rough-and-ready "nest," composed of a gelatinous mass sticking the leaves together, with a contained egg. The number of eggs laid by various kinds of frogs and their allies varies greatly; the species which mother their young lay a reasonable number, fifteen or so at a time, but one species has been observed to lay 28,000 eggs in ten hours.

It may seem peculiar that the custom of enclosing the eggs in a jelly should be so universal; the object is

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probably twofold—the jelly forms a food for the young animals when they have consumed all the food in the egg, and also the envelope acts as a protection for the eggs. Frog spawn slips readily through the fingers ; by the same rule it is not easily snapped up by ducks and other creatures anxious to make a meal of such fare.

The Surinam toad is one of the most curious of all the amphibians, a name, by the way, which does not accurately describe our example, for it is wholly aquatic. In ordinary times this toad is remarkable for the wart-like growths which cover practically the whole of its body. At pairing time, which occurs during the rainy season, the male places the eggs, as they are laid, one by one on the back of the female. Each egg is sticky and so adheres to the spot where it is placed. Then a very remarkable thing happens : the eggs gradually sink into the mother's back, each one into a little pit which is covered by a lid. In time, of course, the eggs hatch and each little lid is pushed up and a young toad surveys the world from its comfortable resting-place on the mother's back. Thus the mother toad spends part of her life, at anyrate, as a living nursery.

This habit of carrying the eggs is fairly common amongst the amphibia which do not cover their eggs with jelly, but it is not always the mother who acts as a nurse. A Chilian frog, described by Darwin, rivals the Surinam toad for eccentricity of nursing habits. Unfortunately, little is known of its life history, but what is known is sufficient to whet the appetite of any naturalist desirous of more information. The eggs to the number of fifteen or so are placed in the mouth of the father frog. When the eggs are in position they are held in a peculiar sac which grows larger and larger to suit the needs of the growing family, till it extends from the unfortunate animal's throat to his groin. So encumbered does the father frog become that all his internal organs are misplaced to make room for his young. Within the sac

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the eggs hatch, the tadpoles go through their development and the young frogs come into the world at a stage at which they can look after themselves. As we have mentioned, much light remains to be shed upon the habits of this frog; no one yet knows how the eggs find their way into the mouth of the father frog.

Another frog from Southern Brazil has very curious nesting habits. As with most other frogs, its tadpoles live in water, yet the eggs are never laid in that element. The mother frog, when about to lay her eggs, displays considerable ingenuity in selecting a suitable spot. She ascends a tree near some stagnant pool, a tree whose branches overhang the water; she climbs to one of the outer branches and on to what she deems a suitable leaf. Then, beginning at the tip, she clasps the edges of the leaf with her hand-like feet and bends them over towards one another and, at the same time, deposits an egg within the rolled leaf. Her eggs are covered with jelly which not only acts as a protecting envelope but sticks the leaf edges together. Travelling from tip to base of the leaf, folding it and laying jelly-covered eggs all the time, she eventually abandons the leaf as a cone-shaped envelope containing a number of eggs. When the eggs hatch, what could be more simple than for the tadpoles to fall into the water below, and this is what they do.

The clumsily named midwife toad is another amphibian where the male does his duty in the rearing of the family. This toad is very common in certain parts of the continent of Europe, particularly in Spain and Portugal. The male spends most of his time in a comfortable dug-out, in a crevice in some wall, beneath some shelving stone or even in a hole appropriated from a mouse. The female lays her eggs in double rosary-like strings and, after they are deposited, the male obligingly draws the egg masses over his hind legs, much as a mere man pulls on his unmentionables, so that the jelly-covered eggs encircle his waist. Then he goes back to his dug-out and remains in

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hiding during the day ; by night he sallies forth with a dual object, to seek food for himself and to moisten the eggs, either in the dew or in a nearby pond. For three weeks he is sorely hampered by his burden, a fact which does not prevent him from taking upon himself a second batch of eggs should occasion arise. At the end of the third week he betakes himself to water, that the young tadpoles, as they hatch, may find themselves in their natural element.

Before considering the architectural capabilities of the amphibia, let us give a moment to the peculiar antics of the fire-bellied toad. As is well known, very many, the majority in fact, of brightly coloured animals are distasteful to eat. Dozens of examples may easily be called to mind : robins and blister-beetles are two of the number, and the fire-bellied toad is another. No animal will ever touch the little creature if it knows what it is about ; but there comes the rub, for the vivid colours of this frog, in the shape of a scarlet waistcoat, are hidden from view when the frog is in its normal position. Its back is very similar in colour to that of any other toad. Well, when this little toad is in danger, what does he do? Roll on his back and show his red waistcoat? Nothing so crude. He bends his head and the hinder part of his body backwards so as to show as much as possible of his under side ; furthermore, like the true contortionist he is, he so twists his arms and legs that their palms and soles, which are also red, are facing upwards. In this strained and ludicrous position he remains absolutely motionless till the danger be past.

Of the burrowing amphibia the Central European spade-foot toad is the best known. His front feet are so modified and armed with a hard, horny sheath that they form excellent spades. Although quite common, it is rarely seen, owing to the fact that it only comes from its burrow by night and is completely hidden by day. Frequenting sandy places, it digs deep burrows, which,

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owing to the nature of the soil, rapidly become filled in so that no trace of the toad can be seen. In the day-time one might walk over ground literally riddled with the burrows of these toads without being aware of their presence. Should a toad be caught, however, he will utter a piercing little shriek and cover one's hand with a slimy substance smelling strongly of garlic, a proceeding which has earned this creature the name of garlic toad in some places.

Certain South American frogs construct little mud nests in the neighbourhood of ponds, in which they may deposit their eggs. These structures, which vary in size from that of a tea-cup to a foot or so in diameter, are in reality little mud-lined ponds cut off from the main water supply, to afford better protection for the eggs.

More ingenious is the nest of the Brazilian tree-frog, known as the smith, on account of its vocal powers, and we cannot do better than describe its activities in the words of Dr Goeldi, its discoverer. "The smith," he says, "is common in the neighbourhood of Rio de Janeiro, more frequently still in the mountain regions of the Serra dos Orgãos than in the hot lowland. Its voice is one of the most characteristic sounds to be heard in tropical South America. Fancy the noise of a mallet slowly and regularly beaten upon a copper plate, and you will have a pretty good idea of the concert, given generally by several individuals at the same time, and with slight variations in tone and intensity. When you approach the spot where the tree-frog sits, the sound ceases. But keep quiet and it will be resumed after a few moments. You will discover the frog on a grass stem, on a leaf of a low bush or in the mud. Seize it quickly, for it is a most wonderful jumper, and it will utter a loud and shrill, most startling cry, somewhat similar to that of a wounded cat."

Of its tadpole nurseries Dr Goeldi writes: "We soon saw a mass of mud rising to the surface carried by a tree-

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frog, of which no more than two hands emerged. Diving again after a moment's time, the frog brought up a second mass of mud, near the first. This was repeated many times, the result being the gradual erection of a circular wall. From time to time the builder's head and front part of its body appeared suddenly with a load of mud on some opposite part. But what astonished us in the highest degree was the manner in which it used its hands for smoothing the inside of the mud wall, as would a mason with his trowel. When the height of the wall ruled about four inches the frog was obliged to get out of the water. The parapet of the wall received the same careful smoothing, but the outside was neglected. The levelling of the bottom was obtained by the action of the lower surface (stomach and throat principally) together with that of the hands."

The construction of a nursery occupies one or two nights, and the operation might be hastened did the male lend a helping hand. After the mother frog has deposited her eggs within the walls of the nest, both parents remain in the vicinity to see that all goes well; sometimes, however, tropical rains destroy the structure and then the tadpoles are released before they are old enough to face the world alone.

FISHES

As fishes and amphibia are so commonly associated in our streams and ponds, we will group them together here. From man's point of view the fishes are of the utmost importance; they form one of our greatest sources of food, but their habits are not of a nature to impress the man in the street. For the most part fish ingenuity is confined to nest-building and, though few of them construct nests, those that do so exhibit a considerable variety in their ideas of suitable hiding-places for their eggs. The salmon builds one of the most primitive nests of all the nest-building fishes, for it excavates a mere hollow in the

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gravel beds of some clear water stream. At the other extreme are the elaborate nests of the sticklebacks.

Two rather curious facts strike the naturalist bent on studying the nesting habits of fishes: the fresh-water fishes are far better architects and builders than their sea-water relatives and it is almost invariably the male who acts as nurse. An exception to the latter rule is afforded by the British butter-fish, a somewhat eel-like creature, who rolls her eggs into a ball by coiling her body round them; the male and female, in turn, guard the egg mass in this manner. After a while, apparently tiring of their cares, the fishes remove their eggs from the sandy beds where they have lain and deposit them, in clumps, in the holes made by the piddock, a common shell-fish of our coasts whose activities are discussed in another chapter.

The little gobies, sand-coloured denizens of marine pools, go a step further in their ideas of house-building. They select a shell—that of the limpet is often chosen, or even the hard covering of a crab—and turn it so that the hollow of whatever building material they have decided upon is at the lower side; in other words, they make a tent of their borrowed home. From beneath this shelter they hollow out the sand and proceed to make a circular opening at one side. This circular opening is their front door, but, being made of sand, it is liable to collapse at any minute. The father goby, however, is equal to the occasion; he swims to and fro, in and out of his front door, rubbing his scaly sides on his structure as he does so. One might think that this performance on the part of the male fish was something in the nature of an exhibition of delight at having a home of his own; in reality he is covering the sand around the door with a slimy secretion from his body. This secretion holds the sand particles together.

The nest completed, eggs are laid on the inner side of the roof of the shelter. The male, it must be admitted,

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is a useful member of goby society ; he builds the nest, repairs it when necessary, guards the eggs and sees to it that fresh supplies of water reach them, and he does so in this manner : near his front door he takes up his position and, with machine-like regularity, waves his fins so that a continuous current of water passes over his eggs. This is a common habit with many fishes, having as its object the prevention of stagnant water collecting round the eggs.

The bitterling rises superior to nest-building ; it prefers a living incubator for its eggs, in the shape of the common pond mussel. By one of those curious coincidences which are so common in nature that they point to a well-ordered scheme of things, the breeding seasons of the bitterling and pond mussel coincide. For this reason they are able to help one another, though they certainly do not do so wittingly.

The bitterling, be it said, lays very few eggs. Were it as prolific as the ling, which deposits twenty-eight millions of eggs at a sitting, it would be hard on the pond mussel, as we shall see.

The mother bitterling deposits her eggs in the gaping valves of a pond mussel shell ; there they remain, hatch and pass the early stages of their development into fishes. At the time the mother bitterling comes along it so happens that the young pond mussels are seeking someone to take them abroad into the world ; they cannot go themselves, they need someone to carry them. What more natural, then, than that they should cling on to the mother bitterling and be carried by her to new quarters ? We have described the habits of these young pond mussels elsewhere, so we need not discuss the question here ; the advantage to the bitterling and pond mussel of attending to their parental duties at the same time is obvious.

The wrasses, noted as being the only fishes known to go to sleep, lying on their sides as they do so, build

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moderately elaborate nests in hollows of marine pools, using shells, corals, seaweeds, etc., in their construction.

There are one or two examples of fishes which shelter their eggs in their mouths after the manner of some toads. Another fish, after his spouse has laid her eggs, blows from his mouth a frothy substance, which causes the egg mass to float upon the surface of the water ; this floating nest he guards assiduously till the eggs hatch.

None of these builders can compare with the pugnacious sticklebacks, which, although they excel in nest-building, are outdone in fighting powers by a little Siamese fish bred by the natives and kept in captivity with the special object of showing its fighting powers. So engrossed did the Siamese become in the sport of fish fighting that, about seventy years ago, it was necessary to obtain a licence to exhibit such fishes, or rather their combats. The fighting fish of Siam were the source of very considerable revenue to the government.

There are many species of sticklebacks and they are all named according to the number of spines they carry on their backs. The fifteen-spined stickleback is a common marine fish and his three-spined brother is common in ponds. A remarkable fact about the three-spined species is that it may be transferred suddenly from fresh to salt water without suffering the slightest inconvenience.

Certain fishes, the salmon and eel to wit, can also live in fresh or salt water, but the change from one to the other must be gradual or the fish will suffer. The stickleback has only one tool for the construction of his elaborate nest, and that tool is his mouth. His first care is to fix on a suitable spot for his nest, and having done so, the water in the immediate neighbourhood becomes his own property ; no aliens may come within its bounds or they will be compelled to run the gauntlet of the plucky little fish's spines. And they form an armament by no means to be despised. At rest they lie almost flat on his back ; when he is alarmed the spines are erected like bristles on

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a dog's back. What is the object of the stickleback's ingenuity? Why should he trouble to build such an elaborate nest? Well, the greatest enemies of sticklebacks are other sticklebacks, and his nest is necessary in order to protect his wife's eggs from enemies, particularly those of his own kind.

If a few stickleback eggs be taken from a nest and thrown into a stream frequented by these fish "sticklebacks rush at them from all sides and fight for them like boys scrambling for halfpence." The male expends considerable care and time in the construction of his nest; he selects his material to suit the locality, everything, in fact, is done to render the nest as inconspicuous as possible. The floor of the nest is first constructed. Pieces of grass or water weed are brought from afar and laid down with the utmost care on the bed of the stream. Piece by piece they are placed in position, not at haphazard, but interlacing with one another so as to form a smooth fabric.

When his weaving is finished the father fish gives off a sticky substance from his kidneys which sticks the woven plants together; then he places little pebbles upon the structure to prevent it from rising to the surface of the stream. Next he turns his attention to the sides of his nest and, little by little, builds up an arch over his closely woven carpet. The completed nest somewhat resembles a lady's muff, except that the opening on one side is smaller than it is on the other. Beautifully smooth and well finished inside, it is rough and unkempt-looking without. Having completed his early labours, the stickleback assumes his wedding attire of emerald-green, decked with bright pink, and sallies forth to find a mate. By dint of much persuasion he induces a female stickleback to deposit her tiny yellow eggs inside the nest. Over the nest he now keeps careful guard, waving his fins steadily the while, to keep a current of water passing through the nest, a necessity for the efficient hatching of the eggs.

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From time to time he looks to see that all is well, but woe betide any intruder who tries to enter his domain ; retribution will be levied, and quickly. In due course the yellow eggs turn brown, a sign that the young sticklebacks will soon appear. When they do so, they, being like all other children, are anxious to see the world, and then the real cares of the father stickleback begin, for he is kept very busily employed driving them back to the safety of the nest till such time as they are able to fend for themselves.

The habits of the fifteen-spined stickleback are very similar. His nest is built of seaweed, interwoven by threads of a substance given off from his own body, and suspended from a frond of a larger seaweed growing in some sheltered pool. The eggs of this fish are as large as those of the fresh-water stickleback were small ; in fact few fishes lay larger eggs in comparison to their size.

A very remarkable adaptation for securing the safety of its eggs has been described in a small fresh-water fish from New Guinea. The eggs are surrounded by coiled filaments, closely wound, like the india-rubber thread in the core of a modern golf-ball. When they are laid, the filaments uncoil automatically, and the eggs are bound together in a double bunch, like a double bunch of onions. At the same time on the skull of the male fish there is a small bony process, like a bent finger, growing forwards and downwards. Just before the hook process becomes an "eye," the double bunch of eggs is in some way or other slipped in ; as the "eye" is completed it is fixed, and the male goes about with the developing eggs on the top of his head. This case is particularly interesting because the two adaptations, which so perfectly fit, are, as it were, very far apart—the filaments round the eggs and the bony process on the male's head ; of this the female shows no trace.

The sea-horse, that eccentric-looking, upright-swimming little individual so common in the Mediterranean, is a

Frogs and Toads

careful male nurse. He is provided with a spacious pouch on the front portion, which is really the lower portion of his body. In this pouch he carries the eggs of his wife wherever he goes. The young hatch in the father's pouch, and not till they are able to face the world and its troubles is he relieved of his living burden.

For the rest there is little to add concerning the ingenuity of fishes, unless we say a word for the pilot-fish, who leads the shark to his food and receives a well-deserved measure of protection in return for his services, or for the little shooting-fish, which captures insects on which it feeds by squirting a tiny jet of water at them as they settle on leaves by the side of his home.

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S0-EKX-023



NHMRL0023480